Machinery Lubrication

India July-August 2016

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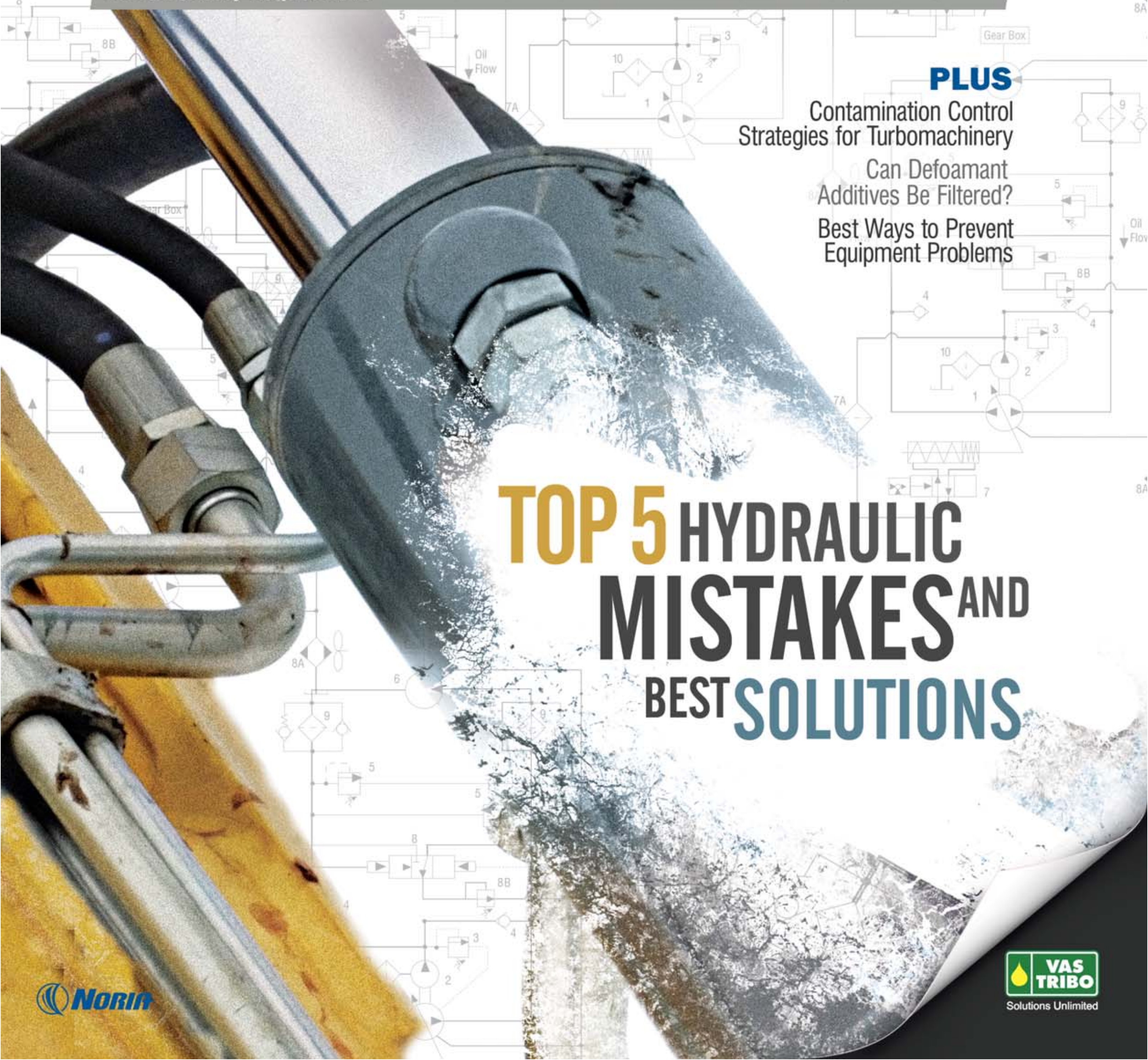

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Contamination Control Strategies for Turbomachinery

Can Defoamant Additives Be Filtered?

Best Ways to Prevent Equipment Problems

TOP 5 HYDRAULIC MISTAKES AND BEST SOLUTIONS

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Publisher's Note

As we prepare to go to press with this issue of "Machinery Lubrication India", we hear about the government's proposal to merge several public sector oil companies to form one behemoth. This will have its pros and cons and needs to be debated and discussed with all the stake holders before being implemented. Whilst on one hand the size and turnover of the proposed "Indian Oil Giant" could take on the likes of Exxon & Shell etc. in terms of economies of scale, but given India's experience in handling big public sector companies like Coal India and SAIL etc would have many wonder if this is indeed the right step the government is contemplating. This may in fact lead to cheeping in inefficiencies and scuttle productivity gains across the board.

There is certainly a case for oil companies to rationalise investments across the value chain, right from exploration and production (E&P) of hydrocarbons, and on to refining and marketing of petroleum products. Indeed, oil refiners and marketers like IOC, BPCL and HPCL have in recent years acquired several E&P blocks both at home and abroad, and upstream specialist ONGC has also revved up its presence in refining and petrochemicals.

It is very much in the national interest to boost productivity, efficiency and innovativeness across oil segments and a single behemoth entity would simply be too huge a disincentive to rationalise expenses and seek synergy. We are set to become the third-largest consumer of petro-products – most of it imported – and instead of promoting a wholly questionable monopoly, it makes perfect sense to step-up competitiveness and openness so as to improve throughput and logistics in our vast oil economy.

It is also a fact that there is path breaking paradigm shift underway in energy and transportation, and oil products are not expected to remain the main automotive fuel in the foreseeable future. The government needs to read the writing on the wall and overhaul market design in oil. It actually needs to unlock shareholder value and gainfully divest in the oil sector for a more competitive marketplace. In parallel, instead of effectively ring fencing the lucrative oil marketing and retailing segment only for the oil companies, we need to open it up for independent retailers, as in the mature markets abroad. The state-owned oil majors seem very smug about the future and spend precious little on research and development and renewable energy. A far greater monopoly would only make matters worse.

This issue also has a User's Guide on "Best Solutions to Top 5 Hydraulic Mistakes". This will help our readers to find best solutions to their questions related to hydraulic breakdowns.

Wishing our advertisers and readers a Happy Independence Day.

Udey Dhir

JIM FITCH, Noria Corporation

WHY Inspection 2.0 Is Your BEST Strategy for Early Fault DETECTION

Inspection, in its most basic form, has been around forever. However, like most things in life, what you get out of an activity depends entirely on what you put in. This column is about radical reinvention of the whole concept of machine inspection. It has little to do with conventional practices of doing daily machine rounds.

With Inspection 2.0, you don't just "look" at a bearing, seal, coupling or pump. Instead, you "examine" these components with a keen and probing eye. Inspection 2.0 is intense and purposeful. It seeks to penetrate and extract information from what's been referred to as machine sign language. Inspection 2.0 requires polished linguistic skills to translate this sign language into prescribed activities and instructions that stabilize reliability.

The technologies of machine condition monitoring have been advancing at a near break-neck pace in recent years. These innovations will continue for decades to come. Still, for the vast majority of machines, there is currently no fault-detecting technology more effective than the razor-sharp and relentless focus of a human being.

The potential of a human being as a condition monitoring instrument is enormous. This potential depends on transformation, specifically from the going-through-the-motions inspections of the past to mission-intensive detective work inspections of the future. That is the essence of Inspection 2.0.

Low-hanging Fruit

Often the simplest solution is the best solution and the right solution. How do you get the optimum level of reliability at the lowest possible cost? How do you achieve a synergistic blend of condition monitoring activities that unifies Inspection 2.0 with the range of other options being advanced and currently available?

Inspection presents some benefits and advantages that are difficult, if not impossible, to duplicate with other condition monitoring options. These include:

- Inexpensive, simple, lasting deployment
- Operator-driven (total productive maintenance emphasis)
- More emphasis on examination skills, less on technology
- The power of frequency and the one-minute daily inspection
- Root-cause-oriented to avoid developing fault bubbles; more proactive, less reactive
- Early fault detection; more predictive, fewer misses and "just-in-time" saves

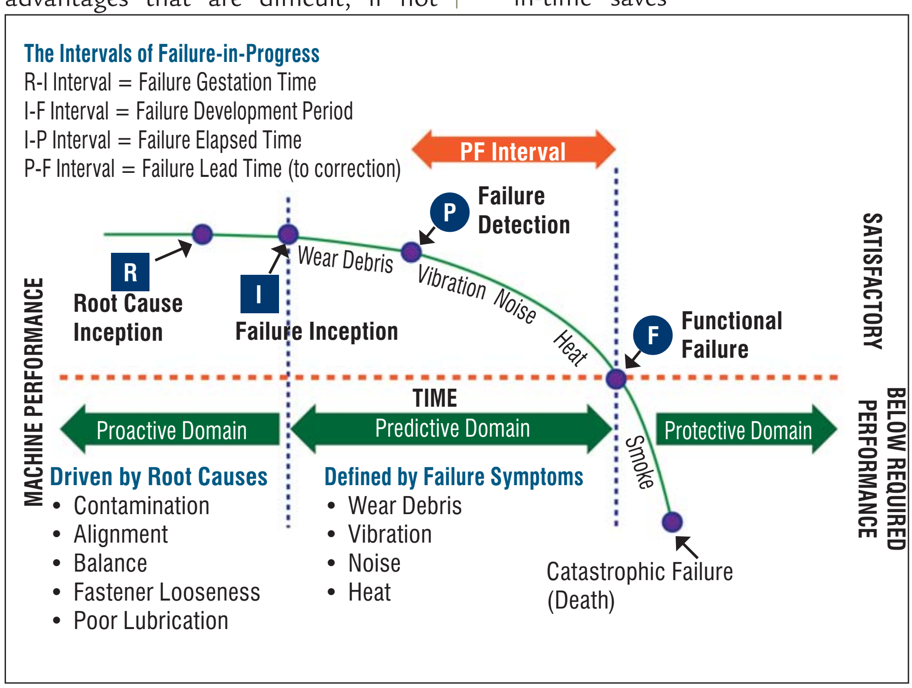

Figure 1. Condition monitoring and the time domains of machine failure

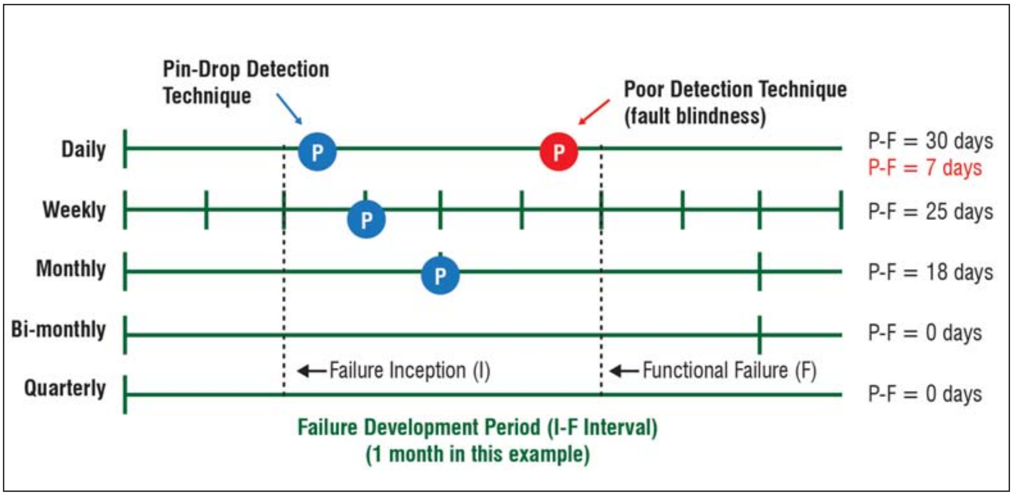

Figure 2. Failure detectability technique and inspection periodicity influence the P-F interval.

We all seek more for less, and no one likes the pain and frustration that often come with exceedingly complex solutions to simple problems. KISS (keep it simple stupid!) solutions should always be your first priority. Their application is at the core of Inspection 2.0. No array of sensors and computer intelligence can outperform a human inspector at a large number of condition monitoring tasks.

Inspection Frequency Trumps High Science

Why not perform oil analysis everyday on just about every machine? Yes, it sounds expensive, but it doesn't have to be. Oil analysis can be done with your senses, aided by inspection windows. Visual oil analysis is real oil analysis. Who said a laboratory is a requirement for oil analysis anyway?

Many of you are familiar with the P-F interval from the teachings of reliability-centered maintenance (RCM). As shown in Figure 1, "P" is the point-of-failure first detection, while "F" is the end-point of functional inoperability. Although the P-F interval is a theoretical concept that has useful application, it is rarely applied in real-world machines. This is because the real world comes with many variable events. These events distort the predictability of the P-F interval. They include:

- Multiple components on a single machine or drive train, each with its own P-F tendencies
- Multiple failure modes for any single component
- Variable duty cycle (speeds, loads, shock, temperature, etc.)
- Remaining useful life (RUL) varies with age. For any given fault mode, the P-F interval shrinks as the machine ages.
- Failure detection methodology and effectiveness vary (ability to detect faults early)

The best countermeasure for uncertain P-F intervals is frequency. For certain machines, real-time monitoring using imbedded sensors is justified, especially high-speed, high-risk machines. However, for nearly all other machines, the simple solution for early detection is daily inspection aided by inspection windows and tools.

Even the world's best laboratory oil analysis programs can't see faults in the "non-sample." Inspection 2.0 asks you to deploy your senses intensely every time you walk by the machine. The oil sample is examined carefully, but it never leaves the machine. See my "Sight Glass Oil Analysis" article at MachineryLubrication.com.

The power of frequency is illustrated in

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Figure 2. In this example, the failure development period (from inception to functional failure) is one month. If your condition monitoring interval is quarterly or bi-monthly, you won't catch the fault prior to functional failure (this is a condition monitoring "miss"). If you use a monthly monitoring interval, you catch the fault with an 18-day P-F interval (lead time to corrective measure). Note, the longer the P-F interval the better.

If your condition monitoring interval is weekly, your P-F interval jumps to 25 days (better). However, if you are able to inspect this machine daily using detection-sensitive Inspection 2.0 methods, your P-F interval is 30 days, which is better than weekly testing with the best condition monitoring technology (vibration, oil analysis, thermography, etc.). By comparison, a poor daily inspection technique yields a P-F interval of just seven days.

Align Inspection Strategy with Failure Mode Ranking

As with any condition monitoring program, inspection strategy needs to be aligned with a ranking of failure modes for individual machines. The order of the ranking is risk-based, i.e., probability of occurrence times the consequences of occurrence. This alignment ensures efficient use of inspection resources and proper deployment of inspection methodology based on need. In other words, each failure mode on the ranking requires a corresponding inspection task or observation that enables the earliest possible detection.

Inspection 2.0 is intense and purposeful. It seeks to penetrate and extract information from what's been referred to as machine sign language.

For each machine, start by ranking failure modes based on the probability and consequence. See the articles on failure modes and effects analysis (FMEA) at MachineryLubrication.com. Next, apply one or more inspection fault detectors for each failure mode. This may require training.

For more on condition monitoring alignment to failure mode ranking, read my "Advantages of a Unified Condition Monitoring Approach" article at MachineryLubrication.com.

Beware of Short P-F and Sudden-death Failures

As mentioned, the P-F interval is almost impossible to predict for a variety of machine-specific reasons. In fact, the interval can vary from seconds to decades. Maintenance departments like long reaction times to schedule needed corrections. Still Murphy's law always looms to ruin an otherwise perfectly good day.

The best strategy to mitigate sudden-death failures is to focus on the early detection of root-cause fault bubbles. This is a fundamental proactive maintenance strategy (see the left side of Figure 1). Fault bubbles are escalating conditions that threaten the onset of an active failure event. As much focus should be spent on preventing the inception of failure as on detecting a failure in progress. Every failure mode has one or more root causes. Ensure good root-cause alignment with your inspection strategy.

Following are a few examples of short P-F and sudden-death failure modes and fault bubbles. What intervention strategy focused on root causes would you apply to detect and neutralize these threatening conditions?

- Oil filter rupture
- Wrong oil or severely degraded oil
- Fish-bowl conditions (disturbed and mobilized bottom sediment)
- Severe shaft misalignment
- Stiction/silt lock of hydraulic valve (motion impediment)
- Grease "soap lock" starvation of an autolube system
- Impaired oil supply of a splash-lubed gearbox
- Heavy fuel dilution of a diesel generator
- Heavy chemical contamination of a compressor oil
- Gross seawater contamination of a shipboard hydraulic fluid
- Shock loading of a large thrust bearing

Inspection Windows and Zones

Inspection 2.0 is searching, detective work. It puts the machine under the microscope day by day. To do this, the

70%

of lubrication professionals perform daily visual inspections of the oil at their plant, based on a recent survey at MachineryLubrication.com

This inspection window finds an active, threatening root-cause fault. Act now! Don't wait for lab results on percent water.

machine's exoskeleton must be penetrated. You have to find ways to see through steel plate and cast iron. You must also "ready" machines for world-class inspection. New products, including modernized sight glasses, are being developed to bring vision to critical zones within the machine.

One of my favorites is the bottom sediment and water (BS&W) bowl. If this sight glass is properly positioned, anything that is heavier than the oil will accumulate there for quick inspection with a good light. This includes sediment, water, sludge, wear debris, coolant, dead additives and dirt. If your BS&W bowl is clear, bright and without sediment, there are many things that could be going wrong with your oil and machine that are not going wrong simply because this sight glass passes inspection.

Figure 3 shows the use of windows for convenient zone inspections. Also included are lists of example root causes and faults that can be visually detected using these windows. For more information on zone inspections, see my "Use Zone Inspections for Early Problem Detection" article at MachineryLubrication.com.

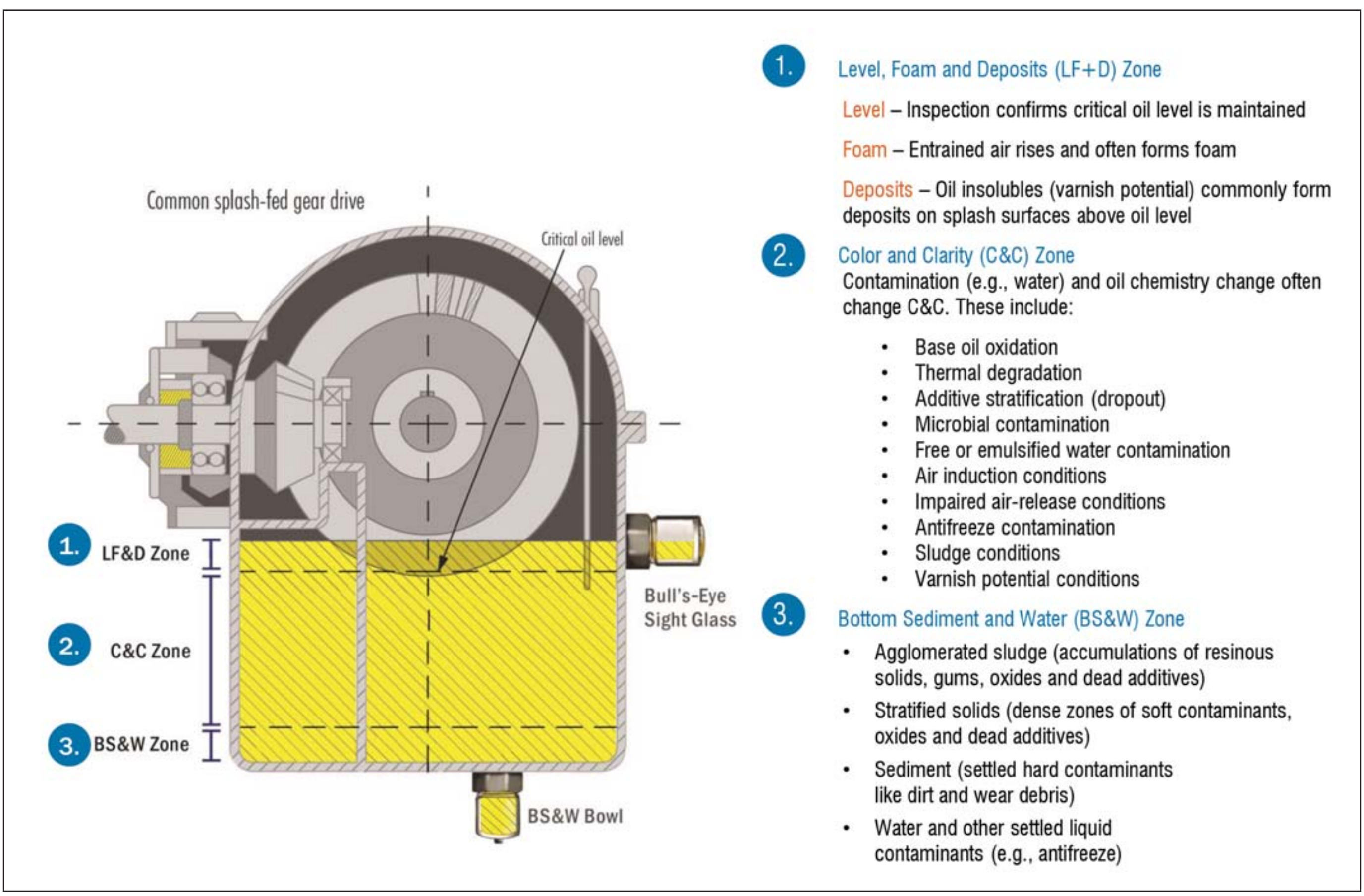


Figure 3. Zone inspections for early problem detection

DISTINCTION	CONVENTIONAL INSPECTION	INSPECTION 2.0
Emphasis on daily inspections	Sometimes	Always
Emphasis on inspection location	Rarely	Always
Installed inspection windows	Rarely	Always
Inspection alignment to failure mode ranking	Sometimes	Always
Inspection designed to preempt fault bubbles	Rarely	Always
Emphasis on early "weak-signal" detection	Rarely	Always
Use of advanced inspection aids and tools	Rarely	Always
Inspectors who are highly skilled and motivated	Sometimes	Always

Inspection 2.0 is a Nurturing Strategy

Applied tribology is a behavioral science. This means that in most plants the practice of tribology and lubrication is people-intensive. I often say that lubricants are what we buy and lubrication is what we do. The main reason machines fail prematurely is the result of what people do or don't do.

Inspection is a subset of tribology (and lubrication) and likewise is very much a behavioral science. People have to passionately want to find faults and reportable conditions. The people I'm referring to are operators, technicians, lube techs, millwrights, mechanics, etc. It's no longer just "looking" during the inspection route and then checking the box on the report. Instead, it's about intense examining, probing, digging and searching. The people factor will make or break any good reliability and maintenance undertaking. This is perhaps more true with inspection.

People respond to work tasks and challenges differently. Much of it has to do with leadership and the maintenance culture. In my "Remedies for a Bad Maintenance Culture" article, I stressed that a positive, nurturing maintenance culture is a critical plant asset. Consider that when people do good work, they feel good about themselves and their job. When people do bad work, they feel bad about themselves and their job. The simple solution is to enable people to do good work that is recognized and celebrated.

Culture drives behavior. Behavior influences quality of work. Quality work is fundamental to plant reliability and the cost of reliability. Of course, this most definitely includes inspection activities. The following list delineates the minimum requirements for building a strong inspection culture:

- Training and inspection skill competencies (optimizing inspection skills readiness)
- Celebrating inspection "saves"
- Inspection KPIs and other performance metrics
- Installing penetrating inspection windows (optimizing machine inspection readiness)
- Availability and use of inspection aids and tools (optimizing tool inspection readiness)
- Promptly responding to inspection-generating alerts and red flags

At the top of the list is training, lots of training. Inspection is so important that I predict in the near future you will see the emergence of new training courses and curriculum focused only on inspection. With that will come certification testing.

Side-by-Side Comparison

What differentiates Inspection 2.0 from conventional inspection practices? It's mostly about execution. The time has come to reinvent this largely mundane and repetitive task. Think about how to make it 10 times more effective with very little extra cost. The table above details several of the main differentiators that distinguish and empower Inspection 2.0 to this higher level of performance.

You'll be hearing much more about Inspection 2.0 in future issues of *Machinery Lubrication* magazine. This is an exceptional low-hanging-fruit opportunity in machine reliability as well as a foundational element for lubrication excellence. Take the initiative to adopt Inspection 2.0 by bringing its powerful capabilities into your organization.

About the Author

Jim Fitch has a wealth of "in the trenches" experience in lubrication, oil analysis, tribology and machinery failure investigations. Over the past two decades, he has presented hundreds of courses on these subjects. Jim has published more than 200 technical articles, papers and publications. He serves as a U.S. delegate to the ISO tribology and oil analysis working group. Since 2002, he has been the director and a board member of the International Council for Machinery Lubrication. He is the CEO and a co-founder of Noria Corporation. Contact Jim at jfitch@noria.com.

Jeremy Wright | Noria Corporation

Measuring the Financial IMPACT of a Successful Lubrication PROGRAM

Let's be honest. When manufacturing organizations launch initiatives for enhanced reliability through lubrication, there's often one main driver behind their decision — money. However, there are many reasons to embark on this journey outside of the obvious. This article should help lessen the challenge of linking those reasons or benefits to a successful program and a favored outcome.

Performing CBAs

The first tool most people use in their journey to acceptance from decision-makers and purse-string holders is a cost benefit analysis (CBA). The CBA can speak the language of managers and leaders. Return, investment and yield are some of the most useful vocabulary terms, as opposed to technical jargon like elastohydrodynamic, contamination control and ferrous wear debris.

Most CBAs are centered around opportunity costs. These costs are currently being incurred but could potentially be eliminated or redirected if the planned improvements were implemented. They are quite easy to associate to dollar amounts, as enough data has been obtained to show what improvements in lubrication and reliability can mean to a company's bottom line.

Beginning with the overall annual maintenance costs, which encompass nearly everything it takes to run the plant at full production for the year, you can whittle away until you find these lost opportunity dollars. More specifically, this annual maintenance cost consists of parts, labor, supervision, management, overhead, insurance, incidentals, etc. You also will want to include unscheduled downtime, excessive scheduled downtime, production de-rates and anything else that might cost the company money because the machines are not operating at 100 percent of their design capacity.

From this total, you can start narrowing down the recoupable money. Start with the percentage that is due to repairs. This will exclude PMs, inspections and proactive activities. Then find the percentage of repairs attributable to the mechanical wear of lubricated components. Of these components, estimate the percentage that is the result of poor lubrication. Finally, determine the percentage that could have been avoided with the proper program in place.

Based on industry averages, approximately 10 percent of a typical

plant's annual maintenance costs could be saved or redirected to other initiatives. This is a substantial amount of money for most plants, but it's not the end of the justification. There is still more on the table.

Understanding ROI

How do you put a value on a failure that you didn't know was going to happen? The problem with only using return on investment (ROI) as a financial benchmark is that it can be extremely difficult to quantify the perceived benefit of the improvement. Many people think only about the value that lubrication excellence has for a

By emphasizing lubrication, oil analysis and reliability, your organization can capitalize on the investment in its physical assets, increasing output, decreasing costs and improving the expected lifespan of components, machines and the overall plant.

reliability or maintenance department and do not consider how the implemented initiatives impacted other departments. For example, training employees leads to better retention, which requires less money spent on turnover and onboarding.

Furthermore, how ROI is calculated differs from department to department and from person to person, making the usefulness of this metric considerably varied and unreliable. Not all lubrication improvements can be predicted with accuracy, such as implementing a condition monitoring program. There's really no way to determine the amount of unpredicted failures you will have versus the ones you will be able to predict through oil analysis, which means an ROI using this number will be useless. Even worse, if you use ROI as your financial benchmark and your implementation does not result in the expected return, obtaining additional approvals based on ROI will be difficult.

Quantifying returns can be challenging, particularly in a plant environment where key information needed to establish the metric is missing. This issue arises when the computerized maintenance management system (CMMS) does not accurately reflect or represent the maintenance tasks performed. So unless you are sure everything will be reported correctly, using ROI as your financial benchmark would be irrelevant to what is actually occurring in your plant.

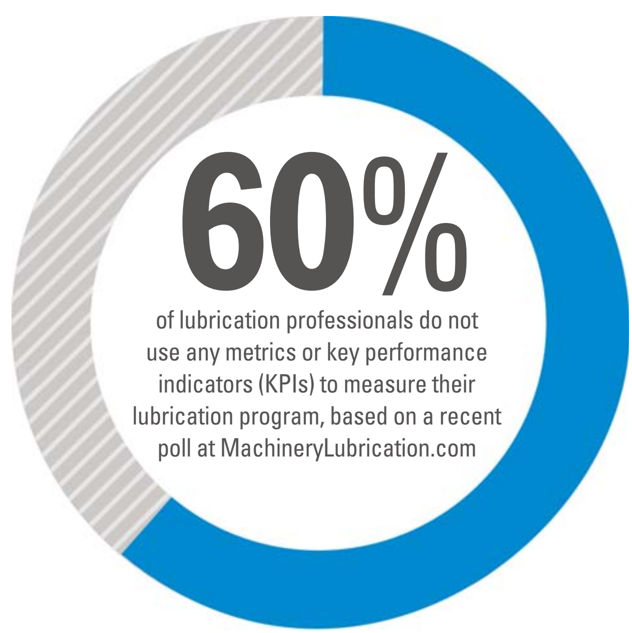
Tracking KPIs

The strategy for recognizing these returns comes down to tracking certain key performance indicators (KPIs). Some KPIs are straightforward and have a direct link to cost savings, but many are indirect and therefore more challenging to link the implemented process to the resulting savings. This may be due to a number of factors, such as a large time gap between the initiative and the cost savings, symptoms that mask the true root cause, or the completeness of the initiative.

I recommend tracking or measuring everything you can. It is important to consider this before any significant changes are made, because you will need a reference point for comparison. If you don't know where you started, it will be difficult to look back and see how far you have come.

Think Long Term

Long-term analysis is another strategy that is often disregarded. Many people have become accustomed to using short-term returns and the need for a net positive cash flow within only a few months. Implementation of a lubrication program can be a daunting task that requires a significant amount of time, money and energy. The results are not like flipping a light switch. They can take months or years to fully realize. Take a step back and try to identify how the initiative will improve reliability and the bottom line year after year. Shifting the culture to understand that an investment today can earn revenue long after the payback period will be a step in the right direction.



Consider the Alternatives

While there are several ways an organization can benefit from a greater focus on lubrication and reliability, the greatest value generally comes from increased equipment availability. Machines that operate longer between outages produce more saleable product. This increase in production by more reliable equipment carries a greater profit margin. Even if the business is not in a sold-out capacity and additional volume is not needed, adjustments can be made in operating shifts to reduce costs.

Increased reliability also results in a more stable process. Those in the continuous process industries will find that the incidence of quality losses due to unstable operation is decreased. This has a corresponding reduction in waste and scrap costs. Minor stops and speed losses are also lessened due to the stability of the process.

If your program improvement initiative is to implement predictive diagnostic tools and performance analysis, consider the alternative and the costs associated with installing spare equipment to make up for all this lost production that you may not have even known you were losing.

An organization with a focus on lubrication and oil analysis understands the operating condition of its assets, which provides enough advanced warning of root cause failure modes to enable "just-in-time" parts procurement. Spare parts inventories can be reduced, cutting carrying costs and releasing working capital for other uses. It's not unusual for organizations to be able to decrease their inventories by as much as 60 percent or more as they implement a successful program.

Don't Overlook Energy Consumption

The financial impact of energy consumption is also frequently overlooked. According to a study by the U.S. Department of Energy, 23 percent of all electricity consumed is through electric motors, and 70 percent of that is in the manufacturing sector. A simple thing like the proper grease volume in an electric motor can account for 5-10 percent more energy consumption. Are you overgreasing because your training, written procedures or calculated routes are lacking? If so, you are leaving money on the table in the form of energy consumption.

By emphasizing lubrication, oil analysis and reliability, your organization can capitalize on the investment in its physical assets, increasing output, decreasing costs and improving the expected lifespan of components, machines and the overall plant. Few investments a company can make will yield as many benefits as a strong focus on these key aspects.

Think Outside the Box

By thinking outside the box, you can come up with even more benefits of program implementation. How will the lubrication improvements impact sustainability programs or safety goals? These aspects are often overlooked, but in a world where consumers care how companies act, it could be in your best interest to include these types of metrics in your justification.

About the Author

Jeremy Wright is the vice president of technical services for Noria Corporation. He serves as a senior technical consultant for Lubrication Program Development projects and as a senior instructor for Noria's Machinery Lubrication I and II training courses. He is a certified maintenance reliability professional through the Society for Maintenance and Reliability Professionals, and holds Machine Lubricant Analyst Level III and Machine Lubrication Technician Level II certifications through the International Council for Machinery Lubrication. Contact Jeremy at jwright@noria.com to learn how Noria can help you make the business case to get your lubrication program off and running.

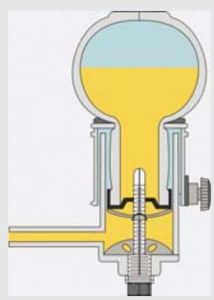
TEST your KNOWLEDGE

This month, *Machinery Lubrication India* continues its "Test Your Knowledge" section in which we focus on a group of questions from Noria's Practice Exam for Level I Machine Lubrication Technician and Machine Lubricant Analyst. The answers are located at the bottom of this page. The complete 126-question practice test with expanded answers is available at store.noria.com.

1. Which additive is not fully dissolved in the (mineral) oil?

A) Antioxidant
B) Anti-wear (ZDDP)
C) Anti-foam (silicone)
D) Anti-rust
E) Viscosity index improver

2. Constant-level oilers:



A) Work through capillary action
B) Cannot be set to the wrong oil level
C) Prevent water contamination of the oil
D) Should be set with the oil level halfway up the lower rollers on bearings
E) Contain a wing-nut level adjuster that can be thrown away

3. After some possible initial change, as oil ages, the base number of an oil generally:

A) Trends down
B) Trends up
C) Stays very flat
D) Oscillates both up and down
E) None of the above

Answers

1. C
An anti-foam additive is a suspended micro-globule additive that is not dissolved. It normally subsides in the bottom of oil containers during prolonged storage, which necessitates proper storage and handling practices.

2. D
Halfway up the lower rollers on the bearings is the correct level in most cases. More or less oil may lead to problems. When the oil level is low, the bearing will not receive enough lubricant for proper film strength, which can result in high temperature, metal-to-metal contact and possible failure. When the oil level is high, churning of the lubricant will occur, accelerating the oxidation rate due to excessive air and elevated temperatures.

3. A
The base number is an important parameter to monitor, especially for engine oils. Engine oil is alkaline (basic) because it is fortified with detergent additives to control deposits and neutralize acids generated during combustion. As the oil ages, these types of additives are used up, leading to a decrease in the base number.

When you turn on the television and surf the guide, you'll often see shows like "Top 10 Beaches in the World," "Top 20 Worst Celebrity Bodies" or "Top 100 Hits of the '80s." So to stay current with the times, this article will cover the top five most common hydraulic mistakes plants make over and over again. This falls into the definition of insanity with which we're all familiar — doing the same thing over and over and expecting a different result. Here are the top five:

Mistake #1: Hydraulic Pressures Are Improperly Set

On every hydraulic system there is a multitude of adjustments to be made. When a machine problem occurs, knobs on the hydraulic pump and valves are adjusted to "see" if this solves the machine problem. Unfortunately, the person doing the adjusting usually has no idea what the effect will be on the machine. Pressures in a hydraulic

Knobs on hydraulic pumps and valves are often adjusted without any idea of the effects on the machine.

system typically are set too high. The thinking is that the higher the pressure, the faster the machine will run. Consider

TOP 5 HYDRAULIC MISTAKES AND BEST SOLUTIONS

By Al Smiley, GPM Hydraulic Consulting

the following real-world scenario that occurred at a wood products plant:

A company had severe shock and leakage problems on a piece of mobile equipment. The pump was also being changed at intervals of once per month. There was an adjustment on the pump (called a compensator), which limited the maximum system pressure. A relief valve in the system was used as an extreme safety device and a shock absorber. The recommended settings for the compensator and relief valve were 1,500 and 1,750 pounds per square inch (PSI), respectively. When the stacker started and stopped, the pressure gauge needle spiked to the maximum of 3,000 PSI, vibrated and then settled in at 1,800 PSI. This indicated that the compensator and relief valve were both set too high. After the compensator and relief valve were reset to the recommended settings, the pressure went up momentarily to 1,750 PSI (relief setting) before settling in at 1,500 PSI (compensator setting). The difference in the force exerted on the 10-inch boom cylinder (78.54 square inches of area) with the relief valve at 3,000 PSI and at 1,750 PSI was 98,175 pounds. Once the pressures were properly set, the shock was eliminated and the life of the pump was increased. After the clamps and O-rings were replaced, the leakage stopped as well.

Mistake #2: Lack of Accumulator and Hydraulic Safety Procedures

When a machine is repaired, the pump's electric drive motor is turned off and lockout/tagout procedures are performed. The pressure gauge is rarely checked before work is begun on or around the machine. Accumulators store hydraulic energy in the form of pressurized fluid. Most systems contain an automatic or manual dump valve that will allow the high-pressure fluid in the accumulator to dump to the tank, permitting the pressure to drop to zero. The automatic dump valves can fail closed, which will maintain the pressurized oil in the accumulator. If a line is taken off or a component removed, an individual can become injected with high-pressure fluid. When a manual dump valve is used, the

Most systems have a dump valve that allows high-pressure fluid in the accumulator to dump to the tank, permitting the pressure to drop to zero.

human factor enters the equation. At one plant, a young millwright was severely injured when he was injected with high-pressure oil after he failed to open the hand valve. There was no procedure in place for opening the valve before working on the system.

Many times the gauge is located on the pump side of the check valve and not the accumulator side. When the pump is turned off, the gauge will drop to zero as the oil bleeds to the tank through the hydraulic pump's internal tolerances. The maintenance person or operator thinks the pressure is at zero and has no way of knowing if the pressurized fluid in the accumulator has been released. On systems of this design, a gauge should be installed at or near the accumulator.

Using a hydraulic schematic is the quickest and easiest method of troubleshooting a machine.

Mistake #3: Poor Troubleshooting Techniques

In our hydraulic workshops, we stress that the quickest and easiest method of troubleshooting a machine is to use a hydraulic schematic. The response from students is usually one of the following: "Management won't give us time to troubleshoot," "We don't have or know where our schematics are," or "We don't know how to read the schematics."

When a hydraulic problem occurs, information must be gathered to determine which component is causing the problem. A few examples include checking the pump case drain flow or checking for heat in the system. Many times the supervisor intervenes and demands that the pump, cylinder or other component be changed. At one plant, a supervisor instructed a millwright not to troubleshoot but to manually actuate a directional valve. This resulted in an accumulator discharging into a partially filled 5,000-gallon reservoir. The top of the reservoir blew off, which shut down the mill for seven days.

Hydraulic schematics are usually located inside the machine manufacturer's manual, which is often kept in a maintenance office or storeroom. When a hydraulic problem occurs, the last thing the maintenance person wants to do is to take 15 or 20 minutes to find the manual. After all, when a machine is down, time is money. A better option is to mount larger schematics by the system under a Plexiglas cover. Smaller prints can be laminated and similarly located. If the schematic is readily available, it will be used.

The most common statement I hear from mechanics and electricians when

consulting with a plant on a problem is, "I don't know much about hydraulics." This means they either have not been trained properly or have forgotten what they have learned. On the other hand, when I visit plants where machinery-specific hydraulic training has been conducted, I normally hear, "We use manuals and schematics all the time." Without the proper training, you cannot expect your maintenance crew to troubleshoot effectively.

Mistake #4: Poor Hydraulic Reservoir and Oil Maintenance

While most plants do a good job of maintaining system filters, the reservoir usually is not given any attention. When a system is designed, the reservoir size is factored into the amount of heat that will be removed from the system. Reservoirs should be cleaned a minimum of once a year to allow some of the heat in the oil to be released to the atmosphere.

On a log-loader in Ontario, the reservoir had not been drained or cleaned in 17 years. A thick layer of sludge was found on the bottom of the tank once the oil was drained. A reservoir that is not cleaned can act as an incubator instead of dissipating the heat in the oil.

Many reservoirs contain a suction strainer. This strainer is located under the oil level and is often out of sight and out of mind. It should be removed from the reservoir at least once a year and

THESE COMMON MISTAKES ARE MADE PRIMARILY BECAUSE OF A LACK OF KNOWLEDGE.

This image shows a tilt hoist with a failed main directional valve.

cleaned by blowing air from the inside out. The strainer should also not be overlooked when troubleshooting. If the strainer plugs up, cavitation of the pump will occur.

One plywood plant changed five pumps on its debarker hydraulic unit. It finally drained the oil out of the tank and found a shop rag wrapped around the strainer.

It should be noted that some strainers have a built-in check valve that allows oil to bypass when the screen is contaminated. This is even more of a reason to clean the strainer regularly, because when in bypass, dirty oil will flow into the pump.

Another common problem is adding unfiltered oil to the system. This should never be done. The oil that leaves the refinery might be clean, but by the time it is stored in transfer trucks and drums, it may only meet a 50-micron standard when added to the tank. Many systems have connections for attaching the fill pump hose so the oil in the drum is ported through the system filter before it enters the reservoir. A standalone filter cart can also be used when refilling the tank to remove contaminants.

Mistake #5: Component Replacements Don't Have the Same Part Numbers

When a hydraulic problem occurs, usually one component has failed. It is essential to match the part numbers between the new and old components. Hydraulic pumps and valves that look alike are not necessarily the same. Each number or letter in the part number indicates a feature about the pump or valve. If one letter or number is different, the manufacturer's literature should be consulted to identify the difference.

A few years ago, a plant had the main directional valve fail on its tilt hoist. The valve had the following part number: DG5S8-2C-T-50. A local vendor was called who said he had a valve with the same spool configuration and mounting pattern in his central distribution center. The valve with the following part number was flown in and delivered to the plant the next day: DG5S8-2C-E-T-50.

When the valve was installed, the tilt hoist cylinders still would not extend and retract. The manufacturer of the valve was then called and given the two different numbers. The original valve (with the letter "E" omitted from the part number) was an internally hydraulically piloted and drained valve. The valve sent by the vendor was an externally piloted and internally drained valve. Since there was no external pilot line connected in the system, the new valve would not work.

To solve the problem, the valve manufacturer told the mechanic at the plant to remove the internal plug in the "P" port and install it in the "X" port. Once this was done, the tilt hoist operated normally but only after 18 hours of downtime.

These common mistakes are made primarily because of a lack of knowledge. When a machine is down, the supervisor, mechanic or electrician is going to do whatever is necessary to get the machine back online in the shortest amount of time. By making sure these top five errors don't occur at your plant, you can reduce downtime, help your plant operate safely and improve hydraulic troubleshooting. ■

By Saul Cizek, Upper Occoquan Service Authority

Embracing Precision Lubrication At UOSA

The Upper Occoquan Service Authority (UOSA) is an advanced wastewater treatment plant near Washington, D.C., with a permit to treat 54 million gallons of sewage per day. The facility, which came online in the late 1970s, receives residential, commercial and industrial waste streams and returns clean water to the Occoquan Reservoir.

Approximately 15 years ago, UOSA management determined that it was imperative to update its organizational approach to asset management. In addition to a review and update of the master equipment records, there would be a more scientific approach to maintenance. A new enterprise asset management (EAM) system and a computerized maintenance management system (CMMS) were implemented to reap the benefits of greater integration of maintenance and financial matters.

Improving Lubrication

One of the first maintenance areas studied was lubrication. The CMMS had listed lubricants but not in a user-friendly way. There were some lubrication codes that specified up to three different lubricant types. An introductory course in lubrication dispelled many wrong notions. The facility was now ready to engage in "world-class" lubrication.

A new oil analysis lab was chosen to test oil samples. The way oil analysis had been managed previously was poor to say the least. The previous test lab made communication a struggle. The new test lab's responsiveness was startling. As a result, UOSA became very conscious of lubricant and machine conditions.

With better oil analysis data being promptly reported, the facility was able to identify the "problem child" machines and swing into proactive mode. During the first 12 months with the new oil test lab, many more machines were added to the oil analysis lists. At the end of the first full year, the data was analyzed. Approximately $28,000 had been saved simply by not changing oil when the test results showed normal conditions. In addition to lubrication cost reductions, those "problem child" machines were fixed before they ran to a catastrophic failure and halted operations.

UOSA has now enjoyed the benefits of a robust oil analysis program for more than 10 years. Training has been provided to all technicians involved with lubrication, which has resulted in more buy-in from the workforce. Progress has been slow but steady. Getting buy-in was a struggle.

For approximately nine years, lubrication enhancements were managed in an ad-hoc fashion by the maintenance planners and crafts personnel. In 2014, the mechanical manager suggested formalizing the program with an eye toward consolidating lubricants.

After agreements were reached on making these improvements, the facility evaluated how lubrication was managed. This included a review of how other organizations had successfully approached lubrication improvement. The standout move was hiring a lubrication consultant, who was furnished with a list of lubrication points on the most critical assets. The consultant spent several days onsite, making field visits to machines and reviewing the CMMS lubricant database. These onsite and field visits helped the consultant develop an understanding of how and what should be changed about the program. More than 45 lubricant types were consolidated down to a list of 17. This was called the "consolidation lubricants list."

Custom lubricant identification tags in production

Proper oil-dispensing containers were ordered to go with the consolidation oils. What had been designated a lubrication room in the new maintenance building had become a catch-all for spares of all kinds and junk. Lead technician Stephen Myers took on the task to clean out this room, add storage shelving, and order consolidation oils and oil-handling equipment. UOSA even received recognition in *Machinery Lubrication's* Lube Room Challenge for this effort.

Custom tags were created to identify and mark each lubrication point. Each tag included the equipment's unique identifier, the given name of the lubricant and the lubricant code shown in the CMMS. Color-coded dots were also added to the back of each tag as another form of identification.

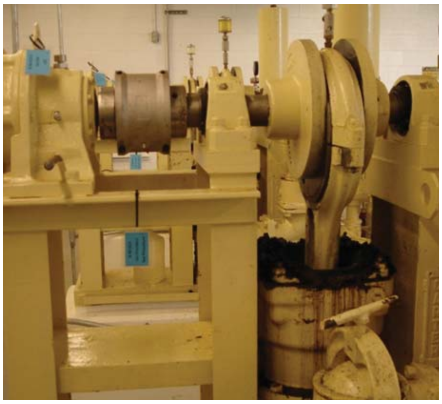
To help technicians remember the three most important points about the lube program, laminated letter-sized sheets were placed in their PM books, hung in the lube room and left in their vehicles. The points were:

- Use specified consolidation lubricant only when the official light-blue lube tag is installed.
- For topping off, use the original lubricant if the official light-blue tag is not installed.
- When in doubt, contact the maintenance planning office with questions about any lubrication matter.

Additionally, all technicians are regularly reminded to contact the maintenance planning office whenever a lube point is changed to a consolidation lubricant.

Obstacles to Overcome

The resistance to change was the biggest impediment to launching lubrication enhancements. Personnel had performed lubrication in a ritualistic manner for so many years that no one felt a need to change. As lubrication reviews were performed, mistakes were found, like extreme-pressure (EP) oil being used in a gear drive with yellow metal components. Oil analysis revealed this error as high levels of copper and zinc in the oil. Incorrect viscosities, oil with the wrong additives and contaminated oil were also discovered on numerous occasions.



An example of how lube tags are hung at the facility

Allowing the maintenance planning office to expand its role in lubrication tasks supported areas into which the field technicians and managers simply did not have time to delve. With a few successes in hand and some avoided catastrophes, word got around and resistance began to fade. The new way was becoming the accepted way.

Refining the Use of Grease

Improving the use of grease was a vital aspect of the lubrication improvements. Many different tubes of grease were in the storeroom. Much of it was ordered and never used or received as spares at the closeout of a project. This selection was reduced to two primary greases and a handful of specialty greases. Colored aluminum washers were purchased to mark grease fittings, and color-coded grease guns were dedicated for these specific greases. This helped reduce bearing failures caused by cross-contamination of incompatible grease types.

Gold-colored grease gun for EP grease

Grease fittings with gold washers

Overgreasing of bearings was another important problem to resolve. There was little incentive to take technicians aside to tell them they were overgreasing, show them the right way and follow up with inspections of lubrication work. This would be changed in several ways. One way was by requiring that all electric motors with 75 horsepower or less receive sealed bearings during any rebuilds. This decision was based on motor repair histories. Where a sealed bearing was installed, the grease fitting was removed and replaced with a plug to prevent greasing. This eliminated overgreasing one asset at a time.

Can you find the grease gun in this picture?

The facility has also been working with acoustic lubrication and using ultrasound detectors to signal when to stop pumping grease into a bearing. Another approach has been to add PM tasks with asset-specific procedures to define the number of strokes from a grease gun to apply at the fitting.

The program is improving steadily, and procedures are being added where a “best guess” existed previously. Grease fittings are still found without lubrication ID washers and protective caps, along with grease spilling out of bearings. On occasion, you might even see grease guns lying in the bed of pickup trucks exposed to the weather.

As frustrating as it is to find some individuals who have not yet fully embraced world-class lubrication, the majority of lubricant handlers were showing interest and making improvements. Perhaps the biggest lesson learned from this experience is how hard it is to change an imbedded culture and how much energy and perseverance are required to sustain change.

UOSA tries to adhere to the Pareto principle, which suggests that 80 percent of your problems come from 20 percent of your equipment. In practice, 20 percent of the total plant equipment provides 80 percent of the benefits and output. The facility endeavors to identify and focus on that 20 percent.

Examples of overgreasing

Unapproved oil bottle

Approved oil-dispensing container

Success Stories

Becoming oriented to world-class lubrication paid off nicely when a biogas-powered reciprocating engine/generator set was installed in 2014. This system uses methane gas produced in biological digesters to fire the engine. In addition to supplying 20 percent of the electrical base load, carbon dioxide is extracted from the exhaust gas and used in the treatment process. Another bonus is capturing the exhaust gas heat to maintain required digester temperatures.

The engine oil requirements for this biogas engine are stringent and allow little compromise. Oil changes for this machine are driven by oil analysis. The staff's accumulated knowledge and experience with oil analysis has helped keep this valuable asset in peak operating condition. Factory representatives have commended personnel several times for keeping a tight rein on engine maintenance.

One event occurred recently where the base number for this engine's oil dropped sharply into a caution range well before customary oil life was reached. Additional oil tests were conducted, and similar results were obtained. When the engine manufacturer's representative was consulted, it was suggested that the content of the biogas be checked. An investigation revealed that the biogas scrubbing elements were exhausted and allowing excessive hydrogen sulfide to pass. This caused the oil additive to deplete and lower the base number. This was another win for oil analysis. It also improved the awareness of maintenance requirements for the scrubbing system.

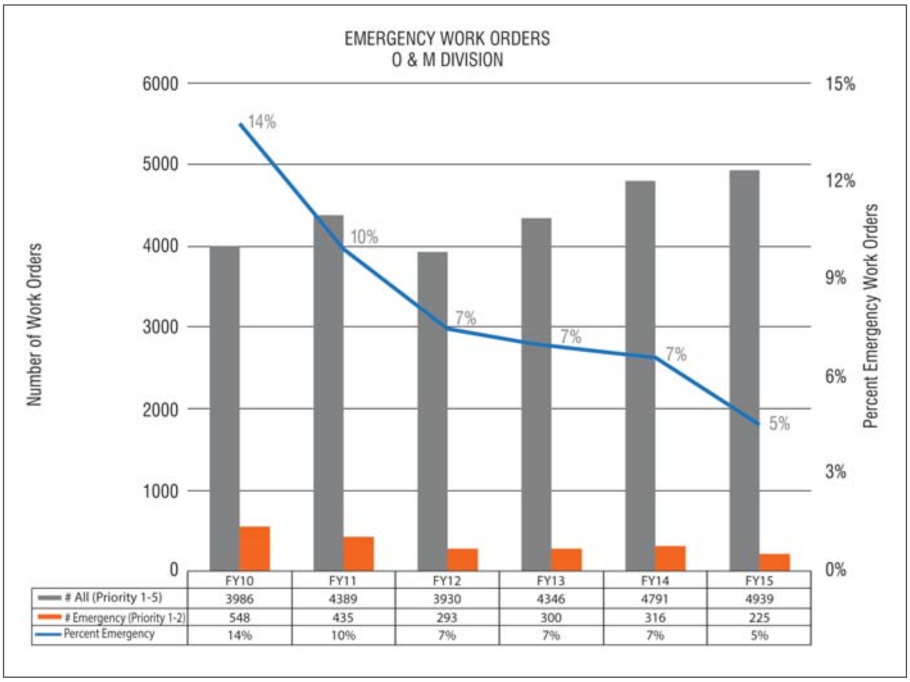
As interest in lubrication grew, UOSA began to experiment with kidney-loop filtration systems where a cleanup filtering might resolve a marginal lubricant condition. The first targets for this process were the large gear drives on the circular clarifiers. Some of these drives have a capacity of nearly 30 gallons of oil. Hauling a portable filter set to the location made better sense. Technicians connected the filter set and monitored filter back pressure during the filtering period. A follow-up oil analysis sample was taken to confirm an acceptable oil condition and check the process. The overall savings in material and labor have made this an attractive maintenance option. This process also allows the asset to remain in service during filtering with no loss of uptime. In fact, it is desirable to have the drive running to get contaminants into suspension in order to remove them.

Desiccant breathers have been installed on the oil reservoirs of outdoor equipment. This helps keep moisture out of lubricants, and there is always plenty of moisture in a water plant.

Another interesting situation concerned failures in a group of mixer worm drives. These units sit out in the elements exposed to heat, precipitation and cold. The initial failures were caused by using an oil of higher than recommended viscosity. The viscosity was corrected. Then water was detected in these drives during oil analysis. The oil was changed, and desiccant breathers installed.

Factory-supplied oil windows were also replaced with a bubble-type oil port, which allowed visual inspection of the oil level and condition. It was noted that the oil still looked "milky," so it was drained, and the drives flushed with a

An oil sight glass with dirty oil (left) and clean oil (right)



new load of oil before a final fill. A week later, when oil analysis was performed again on these drives, water appeared in the sample reports. The percentage of water was less, but it was still there. Prior to this experience, personnel might have let the matter drop after the first oil change and waited for the next oil analysis interval to discover the water. In all likelihood, these drives would have failed before the next oil analysis.

As the lubrication program expands and matures, more stakeholders are buying in. From upper management to junior technicians, it is becoming evident just how much of a foundation good lubrication practices provide. Lubrication is no longer looked upon as a messy job but as the life blood of critical assets.

KPIs Reveal Improvements

In analyzing work orders, the facility began to see more detail in the notes. These details have helped, but they don't necessarily provide quantifiable results. The graph mentioned above shows how emergency work has declined over the years.

While this improvement cannot be directly attributed to better lubrication, it reveals a trend of avoiding emergencies and toward greater equipment reliability. A continuous reduction in the number of oil samples showing a critical condition has also been observed. This represents cost savings and greater uptime. It is believed these improvements are directly linked to better lubrication practices, desiccant breathers, training and pride. Better lubrication practice is a cornerstone of reliable equipment.

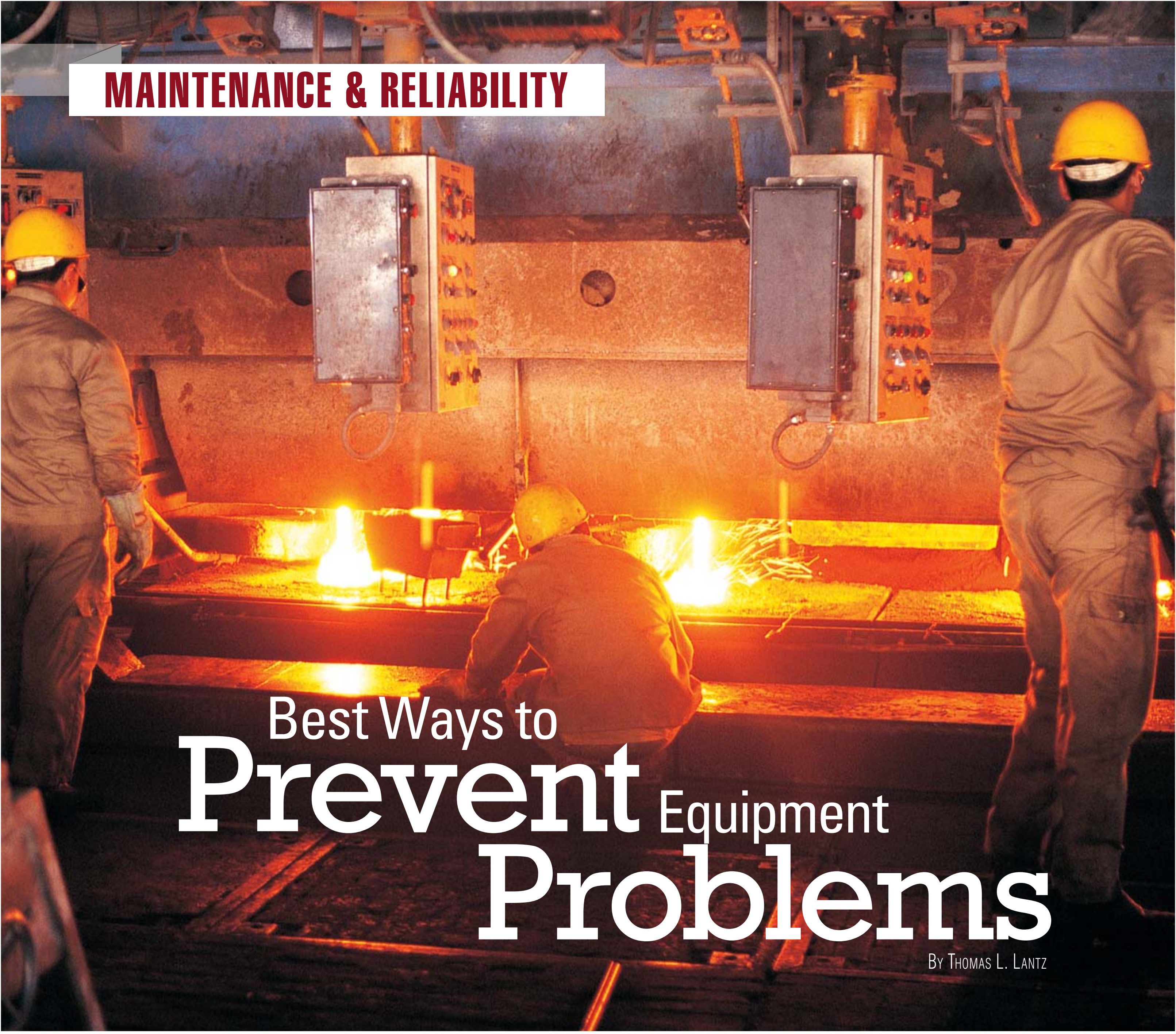
Improving Work-order Histories

After moving to the new CMMS, the plant was better able to record and store work-order histories. The "fly in the ointment" was that the organizational culture had not been prone to record details for work-order history. Often the only finalizing comments written on the electronic work order were remarks such as "fixed it" or "overhauled." There were few comments on the cause of failure and how the corrective work was performed. One impediment to capturing this information was a lack of keyboard skills. Another was the trepidation of technicians to express themselves in writing.

There had been no reward for sharing details, so trade technicians had become somewhat reticent and by turn laconic. Over the past 10 years, a concerted effort has been made to engage and draw out this vital information for work-order histories. The pursuit of world-class lubrication has provided a direct method with immediate and recognizable benefits to show trade technicians that sharing repair history makes their lives easier. It has afforded endless opportunities to compliment technicians and show them the value of their knowledge.

To make work-order histories more useful, the facility has added close-out codes to identify the type of failure. This helps ferret out the bad actors during data analysis. Root cause analysis investigations are actively performed and documented when critical assets are involved. With the lubrication program running and stabilized, attention is now being turned toward precision maintenance.

The single most important aspect in achieving accurate work-order histories is interest. In other words, people in the maintenance planning office must show interest in details. When those details do not present themselves, maintenance planners must go out and hunt them down. It may take some effort to establish a working relationship and get these details, but the rewards are immeasurable. Remember, a single person can start a cultural change, but it takes many people to sustain that change. ■



Best Ways to Prevent Equipment Problems

By Thomas L. Lantz

Preventive maintenance methods are often promoted but rarely put into practice. This article will attempt to encourage a paradigm shift in maintenance thinking with prevention driving most of the activities. The main thrust will be on leadership and not simply management.

Leadership vs. Management

The classic definition of management is to do things right. The definition of leadership is to do the right things. The difference may be subtle but very important. How often have you witnessed someone planning a repair job to be completed within an allotted timeframe when no one was asking why this repair needed to be made so frequently?

A manager attempts to get work done on time, while a leader attempts to minimize or eliminate the required work. A manager continually asks for more people, while a leader tries to maximize the effectiveness of his or her staff. A manager tackles problems as they arrive, while a leader asks why continual problems are tolerated.

Prevention Depends on Leadership

Without proper leadership, problem prevention is very difficult to achieve. The following case studies illustrate a variety of situations in which preventive techniques were used effectively in a typical mill environment.

A Poorly Designed Hydraulic System

In this mill, steel slabs issuing from a caster started as a long, continuous hot metal strand. A torch cutter sliced off 30-foot slabs from the front end as the strand moved at a slow pace. The slabs were lifted off the table rolls and stacked for delivery to a storage yard by a carrier. The tongs resembled two pairs of giant 10-foot scissors operated by hydraulic cylinders and fed by a hydraulic system mounted near the top of the scissor arms. The system had a vertical tank with a pump mounted beside it. Due to space limitations, the valves, tubing and hoses were located directly over the pump and motor, making for a very congested design. The entire assembly hung from a crane. When an O-ring blew or a valve needed changing, quite a bit of disassembly was required to access the bad part. A lot of time was also wasted with repairs on this equipment due to the design.

The cause of the problem was obvious, and only a redesign would suffice. The supplier of the tongs was contacted and told the system design was inadequate. With "manifolding" technology, much of the pipe, tubing and hoses could be eliminated as well as the congestion in the confined spaces. The supplier agreed to redesign this part of the system, which solved the problem. This case exemplified a unique issue where only prevention of future problems would suffice. Learning to live with the problem was not an option.

Inefficient Purchasing of Lubricants

At this particular company, lubricants and hydraulic fluids were purchased by individual departments with no coordination between them. Consequently, the number of brands proliferated, increasing the chances of duplication. Products were procured by brand name, and the purchasing department had no choice but to buy what was requested. Because lubricants were purchased by brand name with no competition, suspicions arose that prices might be excessive. When a problem arose, quality was blamed and another supplier was brought in to solve it.

It was suspected that the company was living with a problem that could be resolved. Because ASTM and other test methods could help determine product quality, a committee was formed to decide how to purchase lubricants based on these tests. A strategy was soon developed. All products would be tested for important parameters to uncover duplicates. Products would be separated by categories such as petroleum hydraulic fluids, fire-resistant hydraulic fluids, general-purpose greases, electric-motor bearing greases, petroleum turbine oils, gear oils, anti-friction bearing oils, petroleum circulating oils and synthetic oils.

Specifications were also written for each lubricant type based on the test results of the higher grades in each category. Every specification was assigned a unique number, and equipment throughout the plant was tagged with the number of the product it was to receive.

The specifications were sent out for bids from various suppliers. The lowest bidder was awarded the business for one year. The prices received were markedly lower than the comparable branded products.

After the initial groundwork was completed, the system began to function well. The inventory shrank because so many locations used the same products. Purchasing in bulk became possible due to consolidation, which also resulted in a reduction in drums and costs. Samples of incoming products were taken periodically to ensure quality. Gradually, the overall quality improved.

The goal of the system was to purchase high-quality products at the least possible cost and to eliminate as many empty drums as possible. Mistakes related to applying the wrong lubricant were also reduced. Once the system was in place, it took very little time to maintain it.

This was an example of a plant living with a problem that not many thought was a problem. It was only after some penetrating questions were asked that most were convinced that there might be a better way of doing things. How the plant was purchasing lubricants was costing much more than necessary both in dollars and in manpower.

Short Motor Bearing Life

In this hot mill, as the steel strand issues from the last finishing stand, a long series of rolls conveys it at high speed to the coilers. Each roll is individually driven by an electric motor. Water cascades down from sprays to cool the strip as it speeds toward the coilers. Despite elaborate splash guards, it is almost impossible to keep water off the motor shafts. The shaft seals were not adequate to keep water out of the motors, and trying different seal designs did not help. The motor repair shop could barely keep up with all the failures. Finally, a seal company recommended adding flingers on the shaft. These consisted of a rubber device that looked much like a shaft seal but with a hole in the center slightly smaller than the shaft diameter. As a motor was repaired and ready to ship, the repairman would slip a flinger onto the shaft up to the housing. When the motor was installed in this wet environment, any water that migrated toward the seal area would be flung off due to the rotating flinger. In this way, water could not get to the seal. Motor bearing life increased tremendously. In this instance, a serious problem was prevented with a simple device but only after someone asked why this was being tolerated.

Frequent Servo-valve Repairs

As steel mill technology improved, more and more servo valves were being used on the mill's hydraulic systems to gain precision. Because of dirt sensitivity, systems with servo-valves must be filtered to extreme cleanliness. Despite great efforts, servo valve losses were becoming excessive at the mill. Costs were also high since the repairs could not be done in-house.

To prevent these failures, a non-bypass duplex filter separated by a three-way valve with an electrical alarm was installed ahead of each valve. The filters had a cleanliness level of 1 to 2 microns. When the alarm sounded, maintenance personnel knew they had only a few minutes to switch the three-way valve to the clean side before a shutdown occurred. A clean filter element was always on standby. The result was that the servo-valve failures virtually ceased.

Once again, a simple design change prevented a serious problem. However, the difference with the servo-valve issue was that production was being affected as well as repair costs.

Excessive Oil Losses

Oil losses were becoming excessive in the mill's hydraulic and lubrication systems. The millwrights dutifully kept the systems filled and operating but did not report all the oil additions as they were made. When additions were reported, there was no good method for determining the amount. Therefore, it was difficult to establish where the bad leaks were and to schedule repairs. Prevention or reduction of these oil

losses was the goal, but they could only be attacked when they occurred.

The decision was made to mount small water meters on the fill lines to each system. These meters had some internal friction, but since the oil was being pumped in as makeup oil, the pressure required was adequate. In cases where the oil flowed by gravity from an upper to a lower floor, low-friction meters were required. Each day, an inspector read the meters to determine if any leaks had gone unreported. If so, action was taken. This was an example of taking preventive action (reading the meters) to prevent further losses. No action could be taken without proper information supplied by the meters.

Rapid Motor Burnouts

The plant's coke oven doors are approximately 20 feet tall and 4 feet wide. They are made of steel, lined with firebrick and weigh about 1,000 pounds. Each is mounted vertically on each end of the oven and must be lifted off by a huge machine so the red-hot coke can be pushed out. The doors are held in place by two steel arms that are rotated into place behind vertical "buckstays." In the center of the arms is a hexagonal nut that is 5 inches in diameter. The arms are rotated by a large socket that fits the hexagonal nut and is operated by a motor and gear reducer mounted on the machine. The arms often become wedged behind the buckstays, so an electrician must hold in the overload relays to get the motor to turn. Frequent motor burnouts were attributed to this practice.

Rather than increase the size of the motors, the decision was made to convert the operation to hydraulic motors due to the inherent overload protection in such a system. Relief-valve adjustment serves this purpose.

Because of the large amount of dirt inherent in the coke plant and the dirt sensitivity of the hydraulic motors, the hydraulic systems were redesigned. This redesign was so successful that no hydraulic motor failures occurred for the first five years. The improved cleanliness also increased pump life. This case was an example of prevention involving a radical design change with which not everyone agreed.

Unchecked Oil Temperatures

At another hot mill in the Pittsburgh area, the challenge was determining the cause of losing several back-up bearings. It seemed to be a case of the oil overheating, but when the coolers were examined, none of the thermometers was working. It also appeared that no one was checking the key system parameters, such as temperature, water content, flow, tank levels and cleanliness.

When the thermometers were replaced, oil temperatures of 175 degrees F were observed. Evidently, the coolers were having no effect. Once the coolers were replaced, the problem ceased.

This was a case of not paying attention to signs that can warn of impending problems. Management hastily instituted a form to be completed on each shift that forced someone to watch those important system parameters.

Misreported Oil Demulsibility

Oil purchased for the mill's back-up bearing system needed to be able to drop out water quickly. The purchasing specifications gave a very strict number that had to be obtained from the ASTM D-2711 test. ASTM D-1401 is another test for demulsibility, but it is used for light oils. The heavier oils utilized for these back-up bearings had to be tested with the former test, although it took much longer than the ASTM D-1401 test.

The mill was experiencing a rise in water levels with samples tested from new loads of oil. Samples taken from in-service oil were having the same problem. Under normal conditions, the water levels should have remained under 5 percent but were now 20 percent. The lab assured the mill that the samples of new oil were within the specification. This situation continued for several months as an investigation was conducted. There were concerns that back-up losses would soon begin rising.

As luck would have it, the lab shut down, which meant the mill had to find another one. When the next sample was sent to the new lab, the mill immediately received a call that the demulsibility was below specification. The load had been pumped out and replaced with a load from another company. It turned out that the old lab had been using the ASTM D-1401 test because it was quicker than the D-2711 test but did not inform the mill. The oil supplier didn't even have the equipment to perform the D-2711 test but was relying on its additive supplier to provide the percentage to use. This was a case of having all the needed tools in place but still getting bad information.

Three Phases of Prevention

These case studies encompass preventive actions for three types of situations: an obvious situation, a change of methods situation and an unseen situation. Each of these is described below.

An Obvious Situation

These situations are like the poorly designed hydraulic system or the electric motor bearing issue. The problem is very costly, and the solution is either obvious or requires a design change. The solution will also require time, money and the will to do it. Most agree that solving the problem is worth a try since it is easily seen. These situations are usually designated as "crises." The alternative is to learn to live with the problem.

A Change of Methods Situation

These situations involve a long-standing way of doing things, such as each department buying lubricants with no attempt at consolidation or not reporting system fluid additions. Although the problems are seen, not everyone envisions a solution or agrees one is needed. Personnel have learned to live with the problem. Basically, the way things are done must be changed.

An "Unseen" Situation

Many times actions can be taken to prevent bad things from happening. These include condition monitoring, regular inspections, close monitoring of system gauges and oil sampling for laboratory tests. Every plant system has parameters that must be checked periodically. These checks consist of people making an assessment of the condition and filing accurate reports. When these people do their jobs correctly, bad things are prevented.

Short-sighted managers only "see" the people who repair things. Those focused on prevention work in a less dramatic environment. Consequently, when the economy is poor, these jobs often are eliminated.

Leaders not only must ensure the "seen" is handled efficiently but also that the "unseen" is not neglected. The "unseen" typically requires recognizing the indications of bad things about to happen, which can often be identified in regular inspections by sight, feel, smell or hearing. However, most of the "unseen" must be detected by equipment. This would include temperature, vibration, sound and lab tests.

The "unseen" also involves a conviction that technology can be used to predict events in order to avoid or plan for them. This conviction is an important leadership attribute. Remember, managers don't see the "unseen," but leaders do. ■

"Would you recommend using aftermarket engine oil fortifiers? Have any studies or research been done on the benefits of using these types of oil additives?"

There are currently more than 50 products on the market that make claims of reduced engine wear, increased horsepower, improved fuel economy, etc. Just about any automotive or general store will have multiple brands and varieties. So what is in them that makes them so special, and are they beneficial?

The product data sheets for all of these products are nearly identical. With a few exceptions, most have an SAE 50 base oil with standard additives. One of the exceptions is polytetrafluoroethylene (PTFE), which was invented by Roy Plunkett of Kinetic Chemicals (DuPont) more than a half century ago. To this day, DuPont claims that "PTFE is not useful as an ingredient in oil additives or oils used for internal combustion engines."

The NASA Lewis Research Center conducted a study in which oil additives containing PTFE were tested. The conclusions of this test were as follows: "In the types of bearing surface contact we have looked at, we have seen no benefit. In some cases, we have seen detrimental effect. The solids in the oil tend to accumulate at the inlets and act as a dam, which simply blocks the oil from entering. Instead of helping, it is actually depriving parts of the lubricant."

Aside from PTFE, many of these products contain a base oil, zinc, phosphorus and sulfur compounds. It should come as no surprise that this is exactly what the oil manufacturer has already put into the oil. The only difference is that when the oil manufacturer adds compounds, it is in very precise quantities, at specific temperatures and in a certain way to give the end lubricant very unique performance properties.

Think of the lubricant as a chemical soup with very specific characteristics. Mixing additional ingredients into the soup will have an effect on the outcome of the recipe. How often do you walk into a world-famous chef's kitchen and

toss in a handful of what you think it needs, not knowing what was in the soup in the first place?

Other important questions to ask before using an engine oil fortifier would include why are there so many Federal Trade Commission (FTC) fines and lawsuits against the aftermarket additive companies for misleading advertising, why don't car manufacturers recommend their usage, where are all the official studies, and who is conducting them.

"If the environment is laden with dust like in coal-handling plants, and dust ingression is unavoidable, what type of grease or oil should be used for bearings and gearboxes?"

The dust in a harsh environment plays little role in the selection of a grease or oil. This role is reserved for attributes such as speed, load, temperature, size, etc. The major role the dust plays is in the selection of accessories and lubrication tasks to be performed on the equipment.

Ingression does not have to be unavoidable. In a harsh environment, one of the most cost-effective measures is to make every attempt possible to seal the equipment. The cost of excluding a gram of dirt is often stated as being one-tenth the cost of removing it later. This can be achieved by the use of several accessories. First and foremost is the headspace management. Every piece of equipment "breathes." You want to make sure that when it does, it is breathing clean, dry air.

There are multiple ways to achieve this. The most popular method to control headspace ingression is the use of desiccating breathers. They not only stop very small particles (often 1 micron or smaller) from entering the headspace but moisture as well.

Your next focus should be on seals. Shaft seals must be properly selected and maintained. Some seals do a good job of retaining oil or grease but do a lousy job of excluding contamination. Lip seals are prime examples, particularly the ones that are only directed inward. These types of seals tend to wear after a period of time because they make rubbing contact with the shaft. Eventually, the seals no longer function well from the standpoint of both oil retention and contaminant exclusion.

On the other hand, a labyrinth seal is non-contacting, so it will not have the wear-out condition. These seals are excellent for excluding particle contamination and moisture, even if there's a spray of water nearby.

Another major source of ingression can be service ports such as dipstick tubes. Unfortunately, the two most common methods for checking oil levels in gearbox applications include using either the supplied dipstick or a level port that must be removed for level confirmation. Both of these methods have the potential to introduce unwanted contamination to the system.

Modifications that may be considered for checking the oil level include the addition of a bull's-eye sight glass into those areas where a level port exists or adding a stand-pipe-style level gauge to the drain or auxiliary side port of the

gearbox. Simply adding a stand-pipe level gauge does not fully address the possibility of contamination, as it is possible to experience contaminant ingress through the vent hole of the level gauge. Applications that utilize an external level gauge should also have the gauge vented back to the case or breather assembly via a T-style fitting.

There is one last point of ingression that everyone seems to either forget or dismiss — new oil. In most every case where particle counting has been performed on new oil, it has been found to be disgustingly dirty. In fact, it is often many times dirtier than what you want running in your equipment. New oil must be cleaned before it is put into a machine component. Missing this one seemingly simple step can be the difference between a clean, reliable machine and a machine that becomes a bad actor.

If you have a question for one of Noria's experts, email it to editor@noria.com.

Wes Cash | Noria Corporation

Can DEFOAMANT Additives Be FILTERED?

The formation of foam is a common problem with lubricants, particularly those with more system turbulence. Foam becomes an issue when it is out of control or when it affects a machine's operation. For this reason, lubricants are formulated with certain additives known as anti-foam agents or defoamants. These additives are larger in size and may be prone to separation in certain cases. As system cleanliness becomes more stringent, it raises the question of whether these additives can be filtered out of the oil.

What Are Defoamants?

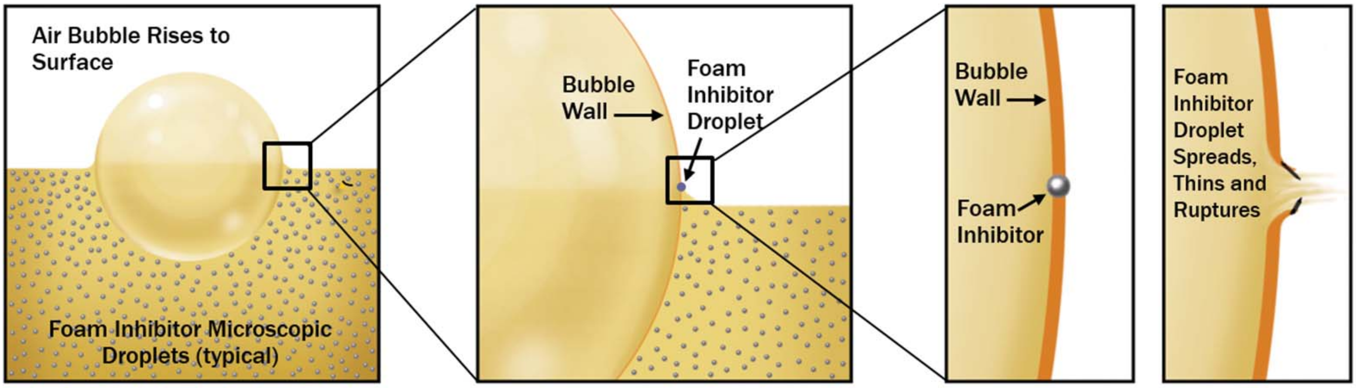
Defoamants primarily exist as one of two chemical compositions: methyl silicone and polymethacrylate. They are blended in oil at different concentrations based on the viscosity and other physical properties of the lubricant in which they are designed to work. Sometimes the application also makes a difference in the type of anti-foam agent to be used. For instance, gear oils with higher viscosities have more of a tendency to foam, due to the likelihood of air bubbles residing in the fluid longer, than a low viscosity turbine oil in which the air bubbles can rise more rapidly, accumulate on the fluid's surface and break on their own.

Most lubricating oils are formulated with defoamants to minimize the risk of a stable foam occurring on the oil level's surface. For the lubricant to have the best chance of performing its intended purpose, there must be a delicate balance between defoamants and all other additives blended in the lubricant. If the concentration of defoamants is too low, the machine may experience issues. If the concentration is too high, it could lead to excess foam due to a change in the oil's surface tension, which impairs the oil's air-handling characteristics.

How Defoamants Work

As air becomes entrained in oil, air bubbles attempt to rise to the surface. While a bubble is rising through the oil, it passes through and picks up any number of defoamant additives that are blended into the lubricant. Defoamants are a little different than most additives in that they are suspended in oil rather than dissolved. This is important because defoamants would lose their ability to minimize foam if they were in a dissolved state.

Once an air bubble traps some of these additives in the bubble wall and finally reaches the oil's surface, the defoamant works to impair the film strength of the



How temperature and viscosity influence the foam tendency for mineral oils bubble wall. Think of it as providing a weak spot in a chain. The interfacial tension of oil is relatively high, but the interfacial tension between the oil and the defoamant droplet is much lower. At this point, the additive spreads and ruptures, allowing air to spill into the atmosphere as the bubble bursts and the stable foam on the oil's surface is minimized.

In a perfect world, defoamants would do their job, and foam would never be a problem. However, these additives can lose their effectiveness as a result of a number of issues. Perhaps one of the most widespread is the contamination of the oil. Any contaminant that impairs the oil's surface tension can diminish the performance of the defoamant. Water is one of the most common contaminants that reduces surface tension and leads to excess foaming. Other contaminants include detergents, solvents, fuels and oxidation byproducts. By keeping out contaminants and maintaining clean oil, you can proactively manage foaming.

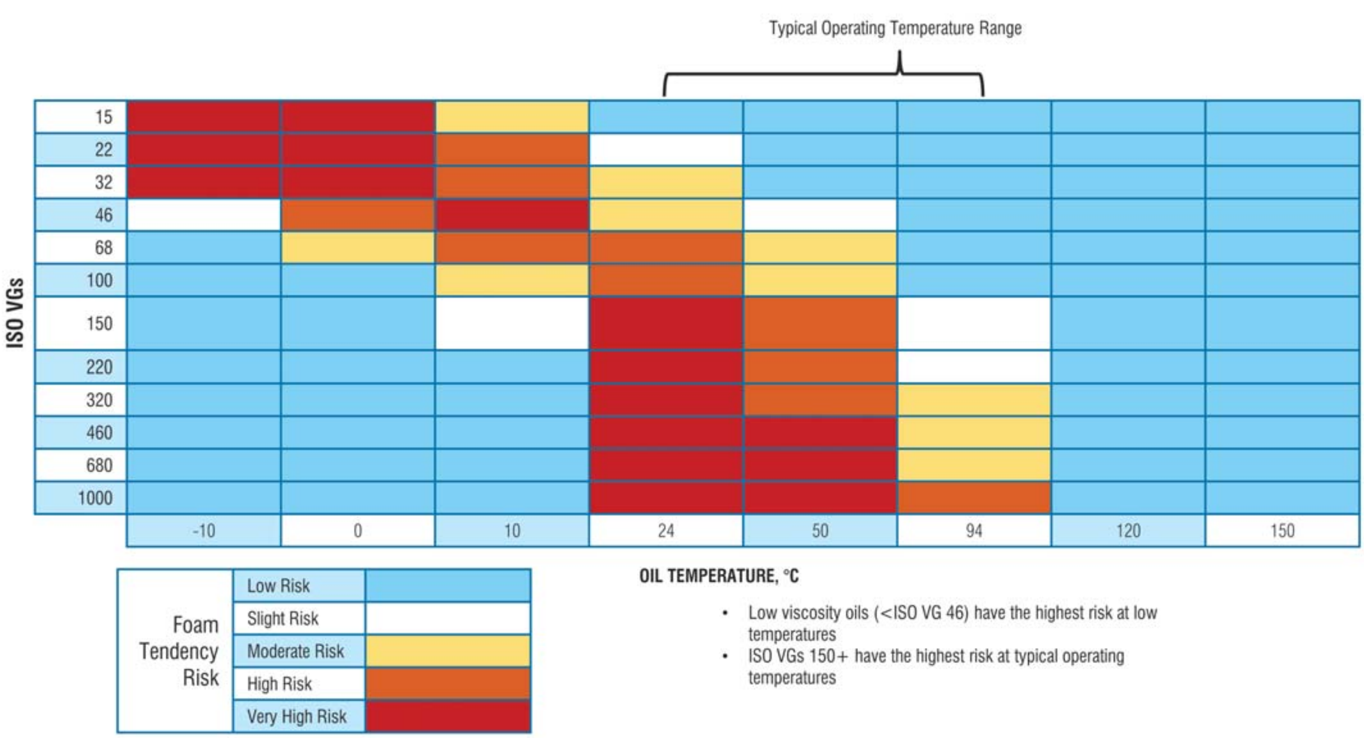
Another reason defoamants become ineffective is because of their removal from the oil. This can occur due to filtration, which will be discussed later, or from the oil being stored for an extended period of time. Since these additives are suspended and not dissolved, they are prone to settling out of the oil. Without sufficient agitation, defoamants may not fully suspend when the oil is added to a machine, especially if the oil has been in storage for a considerable length of time. This is why performance testing of stored lubricants is highly recommended. It is also one of the many issues that can arise from lubricants exceeding their shelf life in storage.

Why Defoamants Are Needed

In most cases, oils will allow air to separate and keep foam at a manageable level. The problem comes with how quickly this must take place once the lubricant is applied to the equipment. Not all machines have adequate reservoirs to give the lubricant maximum dwell time to cool, shed contaminants and allow entrained air to rise and foam to settle. In fact, many machines don't have reservoirs, so the oil is in a constant state of turbulence. This is most common in splash-lubricated equipment such as pumps and gearboxes. In these applications, the defoamant must keep foam at a minimum so as not to impair lubrication for the rest of the machine.

Machines with circulating oil use defoamants to prevent foam in the reservoir and to reduce air-related issues such as vapor lock in other locations within the lubricant system. These additives greatly increase how fast foam settles and disappears so it doesn't impair the function or health of the machine in which the lubricant is operating.

By keeping out contaminants and maintaining clean oil, you can proactively manage foaming.



Risks Associated with Foam

While a certain amount of foam is acceptable, it can easily get out of control and lead to decreased lubrication. In splash-lubricated machines, excess foam can reduce the oil's splashing ability and result in lubricant starvation for some components. In circulating systems, foam may restrict the oil's ability to flow through piping and cause issues such as pump cavitation. Hydraulics may also experience spongy or erratic control if the fluid is foamy.

In terms of lubricant health, foam is detrimental to the overall life of the oil. The most common form of oil degradation is oxidation. Foam has a high percentage of air, which is the chief ingredient in the oxidation process. As foam progresses and limits the equipment's lubricating tendency, the oil temperature begins to rise. With an increase in operating temperature and plenty of air intermingled in the oil, oxidation occurs at an increased rate. This directly impacts the lubricant's health and how often the oil must be changed.

There is even some environmental impact associated with excessive foaming. If the oil level cannot be managed, it can lead to spillage as foam seeps out of open hatches, breather ports or seals. The oil then becomes a risk to personnel who could slip, trip or fall. It also becomes a hazard if it gets into a sewer system that is not contained to the plant. If this happens, not only must some type of secondary containment be placed around the machine to contain the spill, but action should be taken to correct the problem causing the foam.

Removal by Filtration

Studies have directly linked lubricant foaming issues with defoamants being stripped due to filtration. Indeed, it is possible to filter out these additives, and if they are no longer in the oil, they will not provide any benefit. Unfortunately, there is not a one-size-fits-all approach to ensure filters aren't impairing additive levels, since there is variability in the formulation and concentration of defoamants required for equipment.

65%

of lubrication professionals report that foaming has been a problem in the oil at their plant, based on a recent survey at MachineryLubrication.com

With standard depth media, there is inconsistency in the filter's pore sizes. This allows certain additives to make it through while others are removed. Much of this will depend on the filter's average pore size and how efficient it is at the selected micron size. Some defoamants aren't solid and can even squeeze through smaller pore sizes.

How to Properly Size Filters

According to filter and lubricant manufacturers, defoamant filtration is most common when oil is "overfiltered" or when the selected filters are too aggressive for the fluid they are charged with decontaminating. While overfiltering can occur, it is rare. Most industrial facilities underfilter their oil or do not filter it at all.

To choose the proper filters for your equipment, you first must set the target cleanliness level. Once the target cleanliness has been set, you can identify a suitable filter to achieve that level. When in doubt, ask the oil or filter manufacturer for specifications.

The general consensus among oil companies is that the biggest risk of filtering out defoamants begins at the 3-micron level. The most widespread application of this type of filtration is in hydraulic and turbine systems, which demand the most stringent cleanliness. Gear systems usually don't require super-clean fluids and thus don't need this fine level of filtration. Therefore, it is important not only to consider machine requirements but also the ability to filter oil to this level without damaging additive levels.

How to Monitor

If a defoamant is silicon-based, it can be monitored through normal elemental analysis of the oil sample. When silicon levels drop, you know the additive is being depleted. The best way to monitor organic additives is to conduct performance testing such as the foam stability or foam tendency of the fluid. By comparing these results against new oil, you can judge the additive's ability and function. Of course, checking for signs of foam in your daily inspection of equipment level gauges will offer the best indication of any potential issues.

Given proper attention and care, defoamants can work well for your equipment and lubricants. Just be sure to size filters accordingly and routinely monitor additive levels to ensure they are working properly and staying healthy. ■

About the Author

Wes Cash is a senior technical consultant with Noria Corporation. He holds a Machine Lubrication Technician (MLT) Level II certification and a Machine Lubricant Analyst (MLA) Level III certification through the International Council for Machinery Lubrication (ICML). Contact Wes at wcash@noria.com.

SHELL LUBRICANTS INDIA CLUSTER APPOINTS

Ms. Mansi Madan Tripathy as its new Managing Director

Mansi, former CMO, Shell Lubricants India Cluster, to take over her new role with effect from August 1, 2016

Shell Lubricants India announced the appointment of Ms. Mansi Madan Tripathy as the new Managing Director of the company. Mansi, former CMO of Shell Lubricants, would succeed Mr. Nitin Prasad, who moves on to take over as the Chairman of Shell Companies in India with effect from August 1st, 2016.

Mansi brings in 20-years of marketing, sales, insights and strategy experience to the office. In her new role, she shall be responsible for leading all the business activities for the Lubricants business in India, Bangladesh, Sri Lanka and Nepal. Mansi has been the architect of digital marketing & social media footprints for Shell Lubricants in India. Leading the marketing team at Shell Lubricants , Mansi has been an advocate of a new direction; weaving 'direct consumer connect', 'industry influencer engagement' and 'greater awareness initiatives' intractably into the company's brand marketing strategies. With her in-depth global knowledge of the market structures, consumer psychology and trade dynamic, as MD, her focus shall be to strengthen the company's presence in India, delighting our customers and consumers and building an organisation that's motivated and growing. Building and maintaining relationships with key business stakeholders and streamlining the efforts of Shell Lubricants across the country shall also be an important aspect of her new role.

Prior to Shell Lubricants, Mansi's experience spans across 17 years at P&G in key positions like Director for Global Male Grooming, P&G and Asia Pacific Head for Consumer and Market Knowledge. As part of her global leadership roles, she has worked across countries like Geneva, Singapore and Boston; working on diverse product categories, new initiatives and equity development of global brands like Pantene, Olay, Vicks, Gillette, Pampers, Whisper, Ariel and Tide.

Mansi is a B. Tech degree holder in Electronics and communication from National Institute of Technology Kurukshetra and an MBA in Marketing from S.P. Jain Institute of Management & Research.

VEDANTA SIGNS AGREEMENTS WITH SOUTH AFRICAN COMPANIES FOR UNDERGROUND MINING TECHNOLOGY

Agreements signed by Hindustan Zinc Limited, a subsidiary of Vedanta Limited

Vedanta Limited, India's leading diversified natural resources company, today announced that it has signed two memoranda of understanding (MoUs) with South African companies for the development and supply of equipment, and the transfer of technology, with the aim of improving safety and productivity at the mechanised underground mines of Vedanta's subsidiary, Hindustan Zinc Limited (HZL).

The first MoU relates to development of ground support systems that are critical for operational safety in underground mines. It is envisaged that these systems will be manufactured in India. The second MoU covers the manufacture of underground utility equipment and specifically the development of local skills in India to maintain this equipment.

Mobil

Ace Micromatic Group

EXXONMOBIL COLLABORATES WITH MICROMATIC MACHINE TOOLS AS AN OFFICIAL LUBRICANT PARTNER

ExxonMobil Lubricants Private Limited is the official lubricant partner of Micromatic Machine Tools Private Limited, the marketing and service company of the 1,200 crore Ace Micromatic Group that is India's largest machine tool conglomerate. Through this partnership, Mobil Industrial Lubricants will support Micromatic with its advanced range of industrial lubricant products and services, backed by its leadership and expertise in the lubricants market.

Micromatic Machine Tools is the preferred supplier for many Indian OEMs and component manufacturers. Through this collaboration, ExxonMobil aims to offer Micromatic customers its high quality products addressing application needs supported by the Solcare program for coolant management. Mobil distributors' ability to collaborate with the Micromatic service team will ensure customer satisfaction through technical services and on time product deliveries.

In addition, the joint partnership will create greater awareness of using the right oil, at the right time and at right place through training programs, customer education seminars and knowledge enhancement sessions with Mobil and Micromatic engineers. All of these will contribute to the success and strengthening of the long-term relationship.

Mr. Glen Sharkowicz, Industrial Lubricants Marketing Manager, Asia Pacific, ExxonMobil Fuels & Lubricants,

> This collaboration will be ExxonMobil's contribution to "Make In India"
> Mr. Glen Sharkowicz,
> Industrial Lubricants Marketing Manager,
> Asia Pacific, ExxonMobil Fuels & Lubricants

said, "ExxonMobil works closely with equipment builders (EBs) to analyze machinery and equipment trends, as well as identify effective solutions that improve equipment efficiency and performance. Our collaboration with EBs has led to the development of advanced high performance lubricant solutions that our customers can rely on. Our partnership with Micromatic, one of the leading machine tool developers, will help us push the boundaries of lubrication formulation and performance"

Mr. TK Ramesh, CEO, Micromatic Machine Tools Pvt. Ltd, said, "With over two decades of experience and supplying more than 25,000 machines in India and abroad, we understand the demands of manufacturing industries. ExxonMobil's team has used its application expertise and enabled partners like us improve product performance and efficiency of our machines. Micromatic welcomes this partnership with ExxonMobil in light of the growing global demand for Indian-made equipment and we look to leverage our collective knowledge and expertise to bring improved performance and productivity to our customers. We also look forward to Mobil's expertise in selection of appropriate fluids which is in line with our commitment to promote Green environment."

"In India, the machining industry is the backbone of growth for industrial manufacturing. India is progressing towards becoming a technology focused manufacturing hub as part of the government's 'Make in India' initiative. Mobil Industrial Lubricants is proud to partner Micromatic to better understand the needs of Indian component and equipment manufacturers, provide them with customized solutions that will help them achieve a winning advantage," said Shankar Karnik, General Manager, Industrial, ExxonMobil Lubricants Pvt. Ltd.

"As part of our partnership, we have developed a program, which includes a quick reference guide for customers on lubricant management and ensures all

> ExxonMobil helps its customers bring down their "Total Cost of Lubrication"
> Shankar Karnik,
> General Manager, Industrial, ExxonMobil Lubricants Pvt. Ltd.

Micromatic customers across India have access to the right lubricants at the right time, resulting in customer delight and assurance. This allows both Mobil and Micromatic to bring their combined capabilities to achieve new heights of equipment productivity and efficiency," added Imtiaz Ahmed, Asia Pacific Mobil SHC Brand Manager, ExxonMobil Lubricants Pvt. Ltd.

Alejandro Meza | Noria Corporation

Contamination Control STRATEGIES for TURBOMACHINERY

Turbomachinery is synonymous with highly productive equipment, high costs and high volumes of lubricant usage. For this reason, lubricant contamination control is critical for the reliable operation and long life of these machines.

A good contamination control strategy not only will identify potential contaminants but also determine their source and establish methods to control and measure them consistently. Defining cleanliness targets or maximum concentration levels will be important in selecting the appropriate contaminant removal approach.

This article will discuss common contaminants that can be present in turbomachinery, such as solid particles, water, air, heat and varnish, as well as strategies that can be implemented to control them.

Solid Particles

Solid particles can originate from the machine's environment, be produced internally from the machine's operation or be introduced into the machine during assembly, commissioning or maintenance activities. These particles can be harmful based on their size, hardness, weight and angularity. They may create abrasion in sliding surfaces as well as surface fatigue (pitting) in rolling contacts. Very small particles (less than 5 microns) can even cause components to stick when tolerances are narrow, such as in servo valves. Solid contaminants can also generate more particles as a result of machine wear.

Depending on their composition, these types of contaminants can be monitored by different means. Particle counting is the most representative test for measuring the presence of solid particles. Results are generally reported based on the ISO 4406 standard.

For metallic particles, elemental analysis, ferrous density testing or a patch method can be employed to observe particles with a microscope. Elemental analysis and a patch method can also be utilized for non-metallic particles. Organic particles (insoluble suspensions) can be characterized with Fourier transform infrared (FTIR) spectroscopy.

Be sure to define your cleanliness targets and discuss them with the original equipment manufacturer (OEM). You must also consider contaminant exclusion or eliminating the root causes of contamination. This involves the actions required to clean and preserve the lubricant before it goes into service as well as the modifications and procedures to keep the machine's lubrication system isolated from contamination sources. These actions include proper filtration. A centrifuge can also help eliminate high concentration levels of contaminants (e.g., free water, dirt and wear debris).

Finally, don't forget to eliminate contaminants that ingress into the in-service lubricant during normal operation. This can be achieved through similar methods and by using the filtration systems installed on the machine.

Water

Water contamination may come from a variety of sources, including simple condensation of atmospheric moisture. In turbomachinery, water can produce rust and corrosion, impede oil film production, accelerate adhesive wear, and cause vaporous cavitation. Within the in-service oil, water can lead to acid formation, increased foaming, entrained air, base oil hydrolysis and

48%

of MachineryLubrication.com visitors use turbomachinery in their plants, according to a recent survey additive water washing (depletion mechanism). It is also a contributing factor to the formation of sludge and varnish.

Water contamination can be measured in the field with inexpensive instruments, such as a crackle test or a calcium hydride kit. In the laboratory, the coulometric Karl Fischer method deploying co-distillation may be used to reduce the risk of additive interference.

Again, the best strategy must involve contaminant exclusion and removal. Effective methods for removing water include vacuum dehydration, decantation (purging free water) and centrifugation. A good dryness target may be 250 parts per million or 0.025 percent for turbine oil.

Air

Air contamination has two general root causes. The first is related to machine or lubrication system operation where conditions produce high turbulence or low oil residence time in the sump. There may also be an air leak or very low pressure before the oil pump or in the return line. This will generate entrained air, which can lead to foaming.

The second root cause involves the lubricant's condition or health. If a lubricant is contaminated, oxidized or has its anti-foam additive depleted, it will have more aeration problems.

Some entrained air in the sump's return section may be normal due to the machine's operation. However, air should be considered a contaminant if it affects the lubricant health or machine operation. Air bubbles enhance the fluid's contact with oxygen, accelerating oxidation and acid formation. These bubbles may also produce microdieseling.

Keep in mind that air is not a lubricant, so the oil film can fail in critical points. Cavitation may be the result of air bubbles or vapor imploding where the

lubricant pressure increases in the circulating system.

Air can also create a potential safety hazard. Excess foam may seep out of the system or cause spills that affect safety around the machine. For more on air contamination, see the article on defoamant additives in this issue.

A simple field test to monitor lubricant health involves taking an oil sample from the sump and waiting 10 minutes for the foam to dissipate. If a significant amount of foam remains after 10 minutes, it may indicate a concern. Have your laboratory conduct a test to measure the foam tendency and foam stability or perform gas bubble separation. If a warning or alert level is not reported, the issue may be in the system operation.

Oil analysis will be necessary to confirm whether the root cause of the air is in the oil. If it's not, you will need to inspect the entire system carefully to identify excessive churning conditions, verify the oil sump size or detect possible air leaks in the suction or return lines.

Heat

Heat may be generated by the machine's environment (ambient heat, steam, combustion, etc.), normal machine operation or the fluid friction of oil in the lubrication system. Additional heat is produced when there is an abnormal condition in the system, such as an incorrect lubricant, mechanical/operational issues or excessive heat from the production process or environment.

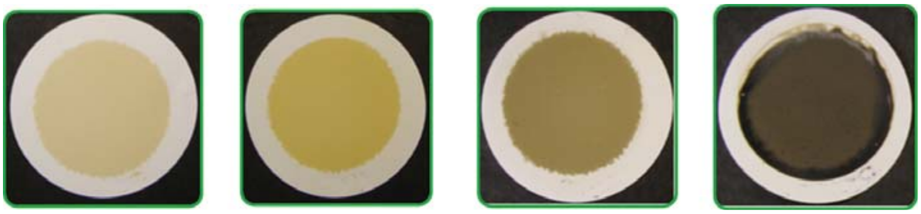
The higher the lubricant temperature, the more prone the lubricant is to oxidize and the shorter its life will be. Temperature is also a factor in the generation of varnish and sludge, additive depletion, and the shortening of machine component life.

Machines have a range of normal operating temperatures that must be identified and controlled. Temperature transducers, heat guns and thermographic technologies are essential tools for monitoring machine and lubricant temperatures. Other indirect instruments may also be used.

It is critical to recognize when abnormal conditions exist and to determine their root cause. Machines must dissipate generated heat to the environment or to cooling systems, so the possible solution will be at this point. The goal is to maintain the operating temperature as low as possible to extend machine and lubricant life.

Varnish

Varnish is the result of a number of factors acting independently or in combination to generate microscopic compounds in the oil. These compounds initially remain dissolved due to the lubricant's natural solvency properties. However, if the concentration of particles continues to increase, they eventually become insoluble and migrate to machine component surfaces. The insoluble compounds in the oil are referred to as varnish potential. The higher the lubricant's



These images show the results of an MPC test on four different oils. The one on the far left is considered to be at the warning level, while the other three are in the critical range.

solvency properties, the more the compounds will remain dissolved without becoming varnish. Also, solvency is highly temperature-dependent. Cool oils and cool machine surfaces are more prone to varnish issues.

Several elements influence an oil's varnish potential, including microdieseling, oil sparking, lubricant oxidation, thermal failure, entrained air and contamination with other lubricants or substances. Depending on the root causes, different types of varnish compounds may be generated. You could say that varnish is just a generic expression of the various possible compounds.

Varnish may be deposited in several components within the lubrication system and can reduce heat-transfer properties, produce filter plugging, decrease lubricant film thickness, lessen flow rates or cause obstruction of lubrication lines or valves.

Membrane Patch Colorimetry (MPC) is a common test used to monitor varnish potential. It reports the concentration of varnish potential by color and provides a score. Other tests that can identify or characterize varnish include ultracentrifugation and FTIR.

Your first course of action should be to determine the root causes of varnish in order to eliminate or minimize them. A formal root cause analysis may be needed along with exception laboratory tests to measure the concentration of varnish and to characterize its type. There are also products available to help correct the problem, although they may not eliminate the root cause. These include detergent additives, base oils that enhance lubricant solvency and high-quality oils such as polyglycols.

Regardless of the type of contamination, the lubricant should be kept clean, cool and dry. It must also be applied in the right place, in the right amount and at the right frequency. If all of these goals are maintained consistently, you will be better able to maximize the performance and lifespan of your turbomachinery. ■

About the Author

Alejandro Meza is a senior technical consultant with Noria Corporation. He has more than 20 years of experience in the lubricant industry, technical services, quality assurance, training, consulting and development in the United States, Brazil, Mexico and the Americas region. Contact Alejandro at ameza@noria.com.

6 Contamination Control Tips

1. Contaminants frequently affect a lubricant's foam tendency and stability as well as water separability. If you detect more foam than normal or demulsibility issues, it may be an indicator of lubricant contamination.

2. Cross-contamination with other lubricants, solvents, cleaning agents or assembly oils may generate varnish and lubricant performance issues.

3. Contaminant removal methods can also remove some of the oil additives. In most cases, this is not a concern, as the benefit of cleaning the oil is much greater than the potential of additives being removed. Of course, there are exceptions. If possible additive depletion is suspected as a result of purification methods, a study should be conducted with the support of oil analysis.

4. Oil sample contamination can result in a false positive report but is not actually contamination of the in-service lubricant.

5. To confirm oil analysis results, resample and retest. Also, be prepared to interpret the results. Some differences can be expected due to the various factors involved in testing protocols.

6. Synthetic lubricants may offer better options for resisting higher operating temperatures, reducing fluid friction and providing better solubility.

Lube-Tips™

THE "LUBE-TIPS" SECTION OF *MACHINERY LUBRICATION* MAGAZINE FEATURES INNOVATIVE ideas submitted by our readers. Additional tips can be found in our Lube-Tips email newsletter. If you have a tip to share, email it to editor@noria.com.

Reducing Hydraulic Failures

In hydraulic reservoirs, baffles are used to prevent fluid just returned to the tank from passing directly back to the pump inlet. For a number of reasons, a longer transit path is considered beneficial. It encourages better heat conduction from the fluid, better contamination control and air separation, and better mixing with the bulk fluid. This is usually accomplished by separating the inlet and outlet by as long of a flow path as feasible.

Oil Sampling Caution

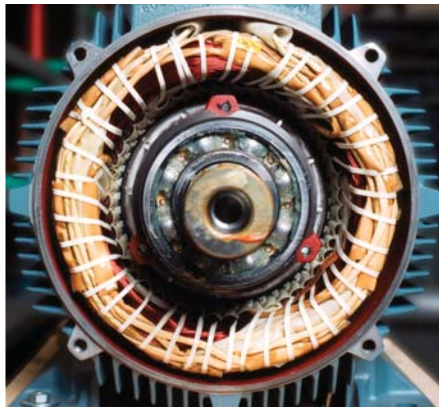
When possible, don't take oil samples from cold systems. Samples that are consistently collected from cold systems will have altered concentrations of wear metals, contaminants and other insoluble suspensions. When at rest, anything heavier than the oil will begin to settle. It takes only two minutes for a 20-micron particle of Babbitt bearing metal to settle 1/2 inch in an ISO 22 bearing oil. If unavoidable, cold systems should be labeled as such.

Lubricant Selection Advice

It is generally a good idea to avoid using extreme-pressure (EP) additives unless they are specifically required to reduce adhesive wear conditions (scuffing, galling, scoring, etc.). Some EP additives can decrease a lubricant's oxidation stability (shortening service life). They can also be slightly corrosive to certain metals (e.g., yellow metals), especially at elevated temperatures.

Keeping Grease Out of Motor Windings

Before greasing motor bearings, install a pressure-sensitive (20-psi differential) grease-fill fitting that will not allow the cavity to be pressurized beyond 20 psi.



This will minimize excessive pressure on the bearing shield and seal.

Also, install a grease relief valve fitting to take the place of the grease drain plug. The grease relief valve will open between 1 and 5 psi and will minimize the overpressurization of the grease cavity. This also saves time in removing and reinstalling the grease drain plug.

Protect Bearings from Corrosion

In a humid environment, condensate can form in rolling-element bearings and cause corrosion, leading to a reduction of bearing life. The condensed moisture's effect can be reduced by carefully choosing a grease lubricant. Greases thickened with sodium soap will absorb (emulsify) large quantities of water but may soften it to such an extent that the grease flows out of the bearing.

Although lithium soap greases do not emulsify water, with suitable additives they can provide good protection against corrosion. There are also a number of greases available containing synthetic thickeners, which offer excellent protection against corrosion to prolong bearing life.

Calculate and Display Lube Metrics

An industrial manufacturing plant found a way to show the effectiveness of its lubrication program to non-maintenance people in the facility. All of the three-part ISO particle count numbers were totaled and divided by the number of equipment pieces that were routinely sampled. This provided a plant-wide average oil cleanliness.

While this number means nothing by itself, every quarter it is recalculated using the latest sample results. This is used to show how the plant's oil has become cleaner as the facility has begun to routinely filter oil and taken other actions to reduce contamination. Everyone can now see that the lube program is having a positive effect.

Bearing Vibration Activates Grease Failure

Excessive bearing vibration can have the same effect as irregular regreasing of bearing contact surfaces. It typically causes the grease to be broken down into the oil and the thickener. That is, the oil separates from the thickener.

Schedule Top-up Container Flushing

A maintenance facility discovered that it is best to put portable oil containers on a flushing schedule along with its equipment. Even though the plant only used new oil in these containers, over time debris would be found in each of them. The facility filtered new oil straight from the barrel, but somehow debris particles would still show up in the top-up containers.

The plant implemented a top-up container flushing schedule to keep contamination control at an optimum level. Once every four months, all portable containers are cleaned and flushed to ensure the debris does not reach the plant equipment. This drastically improved the cleanliness of the oils put in the equipment.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